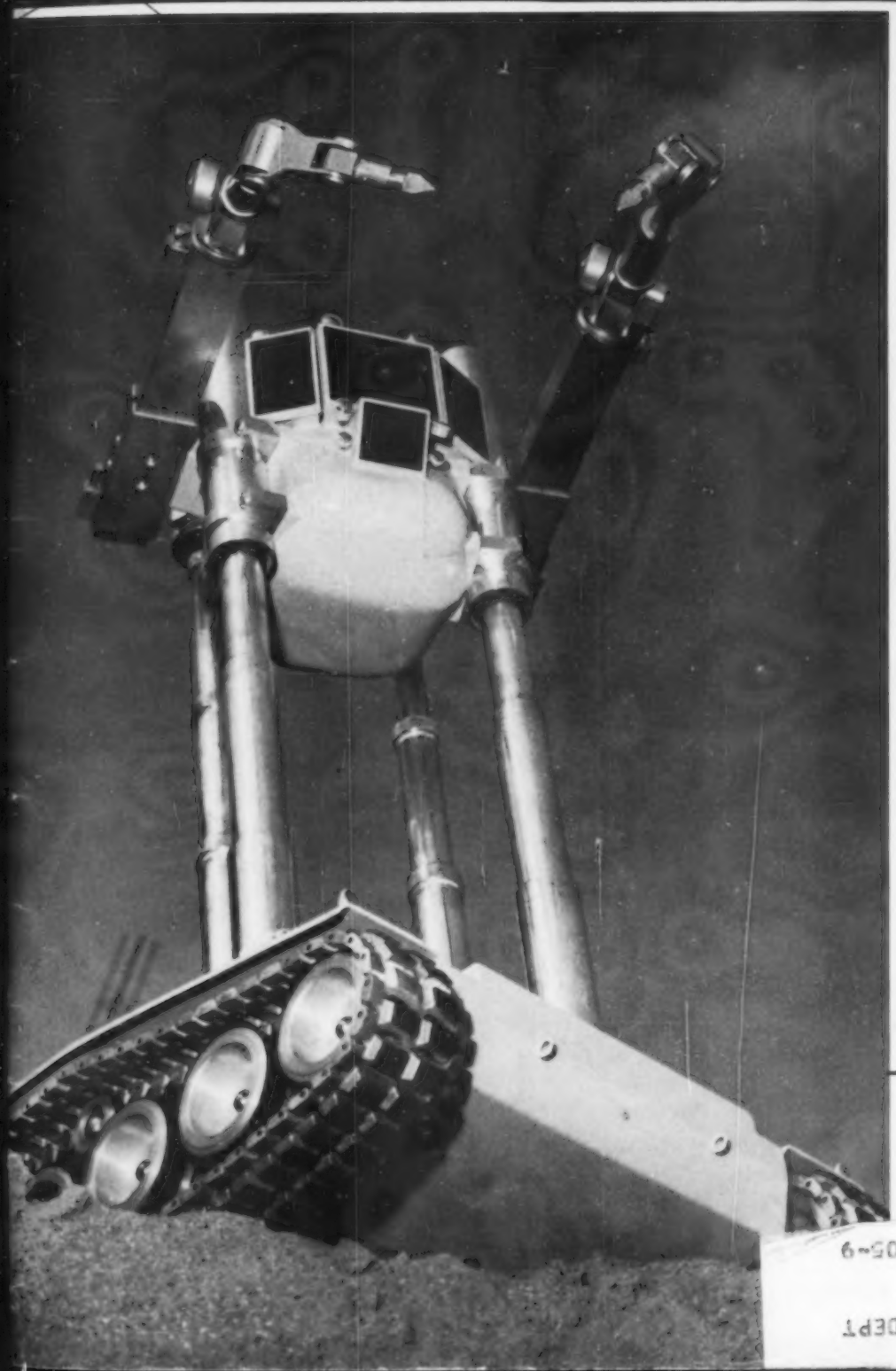
missiles and rockets

THE MISSILE/SPACE WEEKLY



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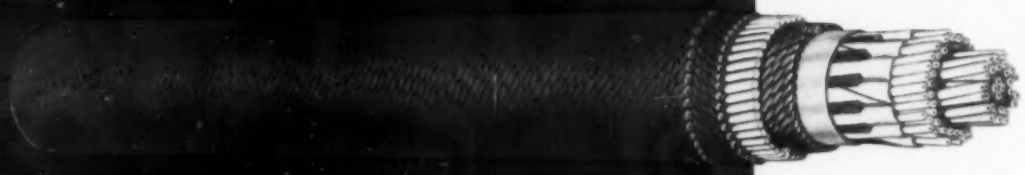

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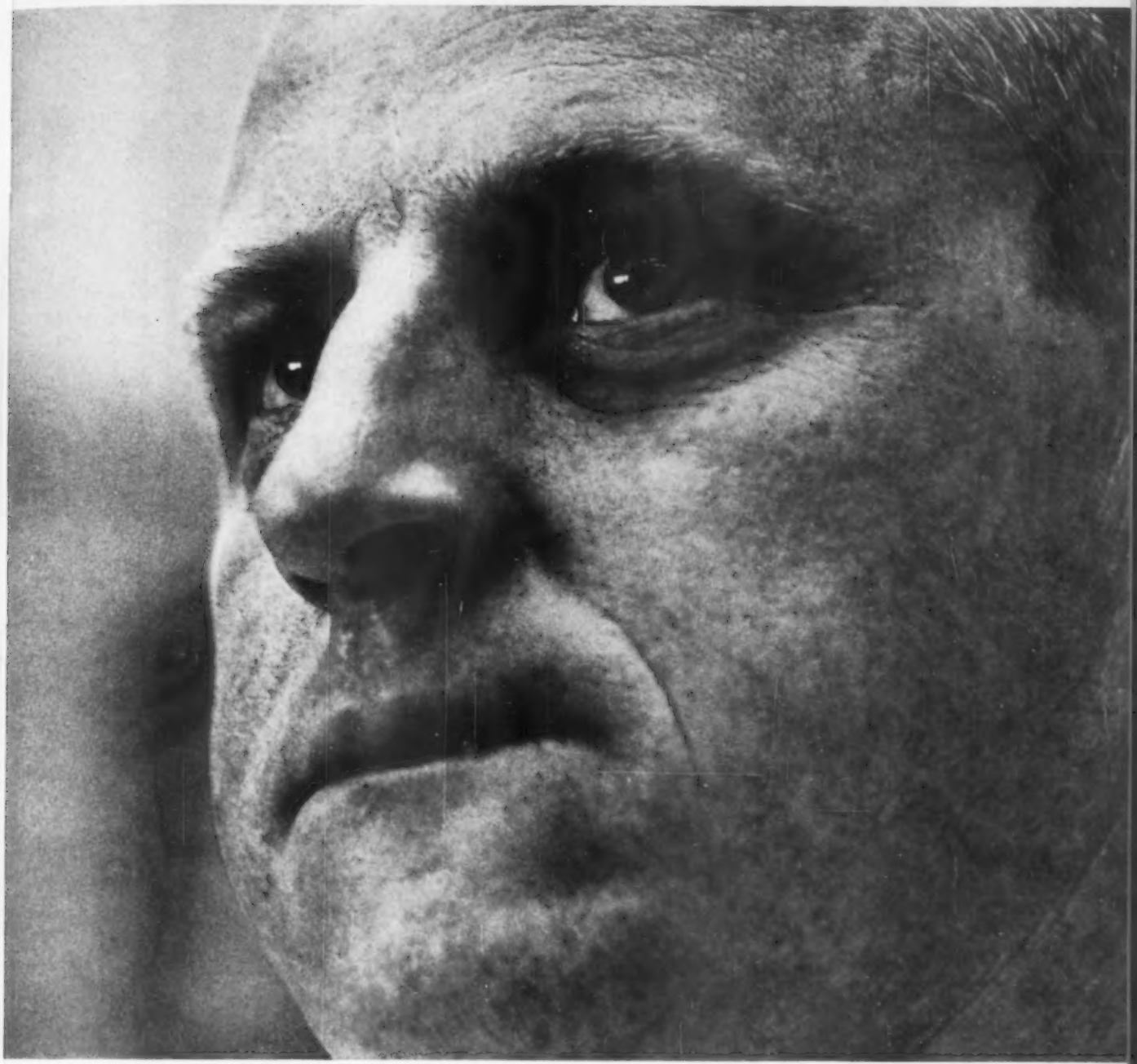

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THE MISSILE / SPACE WEEKLY

missiles and rockets

Volume 9, Number 15 October 9, 1961

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THE COVER

One-tenth-scale model of GE's "Beetle" moves across desert terrain. Eighty-ton shielded vehicle will handle radioactive equipment for the Air Force. See p. 39.

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'Non-Profit' Defender

To the Editor:

Your July 3 editorial ("Thoughts on Non-Profit Firms") is both encouraging and commendable. It's about time someone with courage spoke up to the politicians in this respect. The job couldn't be done "in house"—i.e., civil service military installations—with certain exceptions. Unfortunately, many are incapable of managing themselves efficiently and effectively, let alone a major weapon system. A few private industrial firms are no better off.

However, these "non-profit firms" and for that matter most defense industries, including some government facilities, have worked and are working to achieve the successful and timely development of our major weapon systems in the interest of National Security. Can the same be said about the House Appropriations Committee?

Before the Committee criticizes and denounces the intent of these "non-profit firms," and unjustly accuses them of salary infringement and other (misdeeds), it ought to clean its own house.

I suggest that they stick to politics and leave the National Defense to us.

If they have not read your editorial or magazine, I'd be willing to pay for their subscription so they can be enlightened.

Syl C. Piccoli
General Manager
Triad Associates
Philadelphia

An Eye for an I

To the Editor:

Many times I have noticed that you refer to the Field Army Ballistic Missile Defense System as *FABMIDS*. Why the "I"?

M. M. Watkins
R&D Operations
Army Rocket and Guided Missile Agency
Redstone Arsenal, Ala.

Mr. Watkins is technically correct. M/R spells it with an "i" as an aid to the correct pronunciation. So do quite a few Army officials at the Pentagon.—Ed.

Magazine for Secretaries

To the Editor:

As secretary to the manager of a group that is directly concerned with meteorological sounding rockets and upper-atmospheric measurement systems, I have made it a practice, encouraged by my boss, to become acquainted with the trade magazines in our field, and MISSILES AND ROCKETS gets my vote as the most outstanding. I have found that by reading these magazines I have become a more competent secretary, and of far more value to my boss than just a machine to take and transcribe dictation. I admit that I don't understand a lot of the technology being discussed, however I feel there is no better way to obtain a general knowledge of the developments taking place in the industry today.

I have discussed with several people the possibility of a magazine aimed at the many secretaries concerned with the missile field and/or those laymen who are also interested. I realize that circulation would have to be very widespread to warrant a magazine of this type, but I, for one, would be willing to spend $5.00 per year to help me become better informed about the field in which I am working, and to be able to converse more intelligently with the many people with whom I daily come in contact. If a company realizes how much more a well-informed secretary is worth, and how much more enthusiasm for her job is generated by a knowledge of and an interest in her field. I imagine it might be willing to spend a few dollars a year (which would be returned many fold) on such a magazine.

Perhaps this idea is not feasible, but it's something that I and other of my secretarial friends support wholeheartedly.

Jere M. Noble
Secretary to the Manager
Astro Measurements
Gulton Industries, Inc.
Hawthorne, Calif.

Camera in Focus

To the Editor:

NORTHROP TECHNICAL STAFF EXTENDS CONGRATULATIONS TO MR. (CHARLES D.) LAFOND FOR EXCELLENT REPORT ON 600 MM BALLISTIC CAMERA ("AMR Buys Biggest Ballistic Camera," M/R, Sept. 11, p. 32). HIS STORY IS FACTUAL AND ACCURATE, A CREDIT TO HIM AND THE EDITORIAL STAFF OF MISSILES AND ROCKETS.

MARC NAULT
NORTHROP CORPORATION
HAWTHORNE, CALIF.

To the Editor:

I enjoyed the article very much, but I cannot refrain from making some comments on it. I would like to pass a few of these on to you:

1. The Nortronics ballistic camera is not the biggest ballistic camera ever built, unless one considers only sheer size and weight; the ICF PC-1000 now in use by several government agencies has a focal length of 1000mm, 400mm longer than the Nortronics camera. As you know, focal length and distortion are the prime factors in determining the accuracy of a ballistic camera, not the weight.

2. The ICF PC-1000 has a *minimum* accuracy of 1 part in 200,000 and is believed capable of linear and angular accuracies of 1 part in 500,000—that is, it is expected to locate a missile within ten to fourteen feet at a distance of 1000 miles.

3. The Nortronics camera is certainly

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not the first of its type built in the U.S., —unless, again, you consider sheer weight.

4. The cost of six PC-1000 ballistic cameras would be less than the cost of one of the Nortronics cameras. . . .

I feel that the article, in general, was a good one, especially in the description of the application of ballistic cameras to missile tracking, although the geodetic and structure measurement applications were omitted. But, in the area of Company claims, I feel the article strayed somewhat from the facts. . . .

Charles M. Worthley
Sales Manager
Instrument Corporation of Florida
Melbourne, Fla.

Support for Crater Theory?

To the Editor:

You may not be aware of it, but the photograph published on page 24 of the Aug. 28 M/R sheds some light on a problem that has long puzzled selenographers.

RAY PATTERN from Ranger impact.

To date, there has been no satisfactory explanation of the rays extending from a few of the larger craters on the moon. Your photograph showing the results of dropping a *Ranger* capsule from an altitude of 1000 feet to a macadam surface reveals an interesting pattern of rays extending from the impact crater. The photo inadvertently supports the theory that the moon craters were formed by meteoric impact. So it seems that even before the *Ranger* program has had a successful launch, it has contributed something to our knowledge of the moon.

Benjamin W. Bova
Avco-Everett Research Laboratory
Everett, Mass.

What Time is It?

To the Editor:

In your excellent, multi-colored ad right in the center of M/R, pages 26 and 27 of the August 28th issue, the time at Colorado Springs appears to be 09:16 on the display board. But look at the clock just under the three men in the observation balcony—it reads 7:57 or 7:58. Do I misunderstand the picture, or did this error sneak in?

Charles L. Goodell
Staff Assistant
Space Sciences and Propulsion Division
Stanford Research Institute
Menlo Park, Calif.

Increased technical responsibilities in the field of range measurements have required the creation of new positions at the Lincoln Laboratory. We invite inquiries from senior members of the scientific community interested in participating with us in solving problems of the greatest urgency in the defense of the nation.

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The Countdown

WASHINGTON

Fiscal '63: What's Coming

Here is how some of the key FY '63 program decisions flowing from Defense Secretary McNamara's office are said to look: For the Air Force—about two additional fixed-base 50-missile *Minuteman* squadrons to bring the total authorized squadrons to eight. Also, some new R&D money for mobile *Minutemen*—but no production go-ahead. For the Navy—about seven more *Polaris* submarines, to bring the total to about 36. For the Army—continued underwriting of much of the limited-war buildup; continued R&D for *Nike-Zeus* but no production okay.

New Apollo Date Official

NASA Administrator James E. Webb says the current timetable for the U.S. lunar program calls for a manned landing in 1967-68. This is the first official confirmation that NASA has cut the target date from the oft-quoted "sometime before the end of the decade." Webb also confirms that the U.S. space program in Fiscal '63 is expected to cost at least $3.5 billion. And he says the agency will go back to Congress early next year in an attempt to get a supplemental appropriation to replace a Congressional cut of $112 million in the Fiscal '62 budget.

Monitoring Soviet Missilery

No one in Washington is ready to swear to the accuracy of the latest series of Soviet missile shots into the mid-Pacific because no one is sure of the bull's-eye. But each shot has been carefully monitored as it re-entered and impacted.

Nike Missile Accuracy

Insiders say *Nike* missile units firing at McGregor Range in New Mexico are missing their targets in two out of every ten firings.

Reduction in Mariner's Weight

NASA confirms that the weight of the *Mariner* spacecraft will be cut from 1100 lbs. to 400 lbs. for a Venus launch next year. Reduction was forced by the shift from *Centaur* to an *Atlas-Agena B* due to slippage in the *Centaur* program. (M/R, Sept. 4, p. 12).

More Atlases Combat-Ready

The number of operational *Atlases* is scheduled to reach about 45 in a very few weeks. One new nine-missile squadron at Fairchild AFB, Wash., was turned over to SAC last week. Another—at Forbes, Kan.—is expected to go operational in mid-October. In addition to these, a total of some 27 *Atlas* missiles are listed as operational at Vandenberg, Warren and Offutt Air Force Bases.

Titan I Still Slipping

Latest tentative operational date for the first Air Force *Titan I* squadron—nine hardened sites at Lowry AFB, Colo.—is November. Even that may slip into December. The *Titan* complex at Lowry originally was scheduled to be operational in mid-1961, but it has been plagued by strikes and other difficulties.

NASA Cuts Calorie

NASA has killed plans for Project *Calorie*—designed as a re-entry test for materials to be used in the *Apollo* spacecraft. It would have used *Atlas-Agena B* as the launch vehicle. Officials say the shot would not have provided the necessary velocity. Instead, *Saturn C-1* with a payload of a boilerplate *Apollo* spacecraft will be used for the same test.

ComSat Report on Schedule

Although there have been rumbles of conflict among the members, the ad hoc committee of international communications carriers set up to recommend an ownership plan for a commercial communications satellite system will submit its report on schedule. The committee has clamped a secrecy lid on the report. There will be no public announcement of the contents until it is in the hands of the Federal Communications Commission. Deadline: Oct. 13.

INDUSTRY

S-1^b Engine Choice Deferred

Proposals for development of the S-1^b stage of the *Saturn* booster were handed to industry representatives in New Orleans last week. The firms were told that the stage would have two or four liquid F-1 engines. NASA said a final decision on number of engines will be made before companies get too deep into preparing bids.

Pershing GSE: How Much?

Cost of GSE for the Martin *Pershing* always has been a closely-guarded figure. Price tags on the individual items are kept well disguised in total figures. Now, at least, the price of the *Pershing* launcher made by Universal Match has been disentangled. The launchers cost about $110,000 each.

Saturn Launch Delayed

Technical difficulties forced some slippage in the first launch of the *Saturn C-1* from Cape Canaveral. It's now scheduled to go sometime next week. *Ranger II* also is to be launched from the Cape later this month.

INTERNATIONAL

Nyet to New York

Request of nine Soviet space scientists attending the IAF meeting in Washington for visas which would permit them to take in the big American Rocket Society meeting in New York this week was turned down. Official reason: The Soviet Union has ignored requests that American scientists be permitted to attend a similar space meeting in Moscow. Unofficial reason: Fears they might be in a position to score a propaganda coup if a Soviet space spectacular comes off this week.

Jodrell Bank for Early Warning

Delay in building the BMEWS station at Fylingdales Moor, England, has resulted in a decision to use the Jodrell Bank radio telescope for early warning. Equipment for this will be installed shortly. A succession of strikes has held up work on the Fylingdales station.

The Missile/Space Week

Apollo: Then There Were 5

Only five firms will be competing for the prime contract on NASA's multimillion-dollar *Apollo* spacecraft program when bids are submitted to the space agency this week.

The five are General Electric, Martin, North American Aviation, General Dynamics/Astronautics, and McDonnell Aircraft Corp.

NASA invited 17 firms to bid on the contract for the command module for the spacecraft and the systems engineering for the total spacecraft development program. The organization of bidder teams cut the total to only five.

GE's team includes Douglas, Grumman, and Space Technology Laboratories.

The McDonnell team is made up of Chance Vought, Hughes, Lockheed, and Aerojet-General.

The General Dynamics team will include Avco. Martin and NAA have not set up a team, although other firms would take part if either were awarded the contract.

A big surprise was Boeing's decision not to bid for the spacecraft contract. The firm announced that it was foregoing the opportunity to bid in order to concentrate its efforts on getting one of the contracts for the development of the *Saturn* Booster.

Other invited firms which did not bid or were not able to get on one of the "teams" included Republic, Bell Aerospace Systems and RCA. No disclosure has been made as to whether Goodyear will submit a bid. RCA reportedly will work with Martin if that firm gets the prime contract.

While NASA has permitted the firms to establish bidding teams, it is not restricted to their lineups. It has reserved the right to reshuffle the teams "to make itself the best deal possible."

Shots of The Week

• An *Atlas* plopped into the South Atlantic Oct. 2, 5000 miles from its Canaveral launch site. Aboard were two pods, one containing pyrotechnic packages to simulate fuel cores that later will be used in nuclear-powered generators aboard satellites, the other carrying the inertial guidance system being developed for *Centaur*. The pods were recovered by the Ocean Range Vessel Timber Hitch.

FIRST LAUNCH of a Nike-Hercules from an experimental mobile transporter, reported last week, showed the potential mobility of the antiaircraft weapon.

• The Army announced on Oct. 2 the first successful firing of its *Nike-Hercules* from a new mobile battlefield transporter, the experimental Goer vehicle, during a simulated combat mission at White Sands Missile Range (see photo).

• The *X-15* was flown minus one of its four stabilizing fins on Oct. 4 in a test of the craft's manual stabilization control. For two minutes of the nine-minute flight, the entire stabilization system was turned off to simulate failure. Said pilot Robert Rushworth: "all went well".

An earlier flight on Sept. 28 checked out high-temperature capabilities. Navy Comdr. Forest S. Petersen was at the controls.

• An advanced thrust-control system was tested on the 200-mile flight of a *Polaris* fired from Cape Canaveral on Sept. 29. The Navy described it as an "advanced device being evaluated for possible use in the third-generation A-3 *Polaris*." The use of freon injection is under study for the 2800-mi. A-3 and the longer-range A-4. The plug nozzle also is under study for the A-4.

• An A-2 *Polaris* was launched on a 1500-mi. flight from the deck of the USS Observation Island off Cape Canaveral on Oct. 4, marking the fourth success in seven shipboard firings of the model. It has an 8-2 record in launchings from pads at the Cape.

• Sperry's *Sergeant* missile successfully completed the contractor R&D test firing phase of its program in a number of launchings over the past two weeks, the Army reported. Production of the missile is well under way at Sperry's Salt Lake City, Utah, plant.

Biggest ARS Show

More than 15,000 scientists and engineers are expected to attend American Rocket Society's "Space Flight Report to the Nation" this week in New York.

Some 175 missile/space firms are participating in what is termed the largest exhibit of space flight systems, subsystems, components, equipment, materials and processes ever held.

Highlight of the week is to be an address by Vice President Lyndon B. Johnson at Friday evening's banquet.

Exhibits will cover 95,000 sq. ft. on three floors of the New York Coliseum. They will include: Rocketdyne's exhibit of the eight-engine cluster of the *Saturn* first stage; the McDonnell *Mercury* capsule; Hughes Aircraft's cesium ion engine; B. F. Goodrich's spherical solid-fueled motor; United Technology's conical segmented solid booster; and *Courier*, *Transit*, *Echo* and *Advent* satellites.

More than 50 technical sessions will cover the scientific and engineering problems of space travel.

For the first time, the annual ARS display will be open to the public. There also will be public panel dis-

cussions as well as some lectures.

A Thursday evening panel on U.S. and Soviet space programs will include: Werner von Braun, Marshall Space Flight Center director; Lt. Gen. Bernard A. Schriever, commander, Air Force Systems Command; Hugh L. Dryden, deputy administrator, NASA; Arthur C. Clarke, noted author; Arthur Kantrowitz, vice president, Avco Corp.; and F. J. Krieger, Russian specialist, Rand Corp.

Dr. William H. Pickering, director of Jet Propulsion Laboratory, has been elected ARS president for next year.

Rovers Urgency Asserted

Project *Rover* got a boost from speakers at opposite ends of the country last week. Addressing the International Astronautical Congress in Washington (see p. 14), Harold B. Finger, manager of the AEC-NASA Space Nuclear Propulsion Office, described nuclear propulsion as a necessity for manned interplanetary flights. He said the contract for a RIFT (reactor in flight test) vehicle will be let after the beginning of 1962. He confirmed plans for a 1966-67 flight test date for NERVA, the first U.S. nuclear engine for rocket vehicle application. Launch is to be with a *Saturn*-class first stage.

Meanwhile, in California Rep. Chet Holifield (D-Calif.), chairman of the Joint Congressional Committee on Atomic Energy, asserted that the only hope for passing the Russians in space flight lies in nuclear propulsion. He said the U.S. may end up a "sorry second" if Project *Rover* is not pushed.

Predictions of the Week

When Soviet space scientist Leonid Sedov was asked at the IAF meeting to predict which country will have the first astronaut on the moon, he gave the matter serious thought and then replied: "Information on this is very limited." Then he smiled.

A lunar international laboratory (LIL) will be established for moon research within 25 years, according to Dr. Theodore von Karman. It already is being planned by the International Academy of Astronautics, which he heads. Also predicted: that rocket flights to the moon by then will be as commonplace as a jet airplane trip from New York to Paris is today.

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Arms Control Agency Will

SOME OF the areas in which the new Arms Control and Disarmament Agency will conduct R&D and studies:

- *Detection, identification, inspection, monitoring, limitation, reduction and control of armed forces and armaments including nuclear weapons, missiles and CBR.*
- *Techniques of detecting, identifying, inspecting and monitoring tests of nuclear and other weapons.*
- *Analysis of national budgets, levels of industrial production and economic indicators to determine the amount spent by various countries on armaments.*
- *Control, reduction and elimination of armed forces and armaments in space, in areas on or beneath the surface of the earth and under and on water.*
- *Reduction and elimination of the dangers of war resulting from accident, miscalculation or possible surprise attack.*
- *Methods of maintenance of peace and security during various stages of arms control and disarmament.*
- *Scientific, economic, political-legal, social, psychological, military and technological factors related to the prevention of war.*
- *Training of scientists, technicians and other personnel for manning possible arms control systems.*
- *Economic and political consequences of arms control and disarmament including the problems of readjustment arising in industry and the reallocation of national resources.*
- *Structure and operation of international arms control organizations.*

by James Baar

THE NEWLY-ESTABLISHED U.S. Arms Control and Disarmament Agency is expected to become the control center for a highly diverse, multimillion-dollar R&D program which will offer extensive contracting opportunities for the missile/space industry.

For the first time, the government will put under one roof the many studies and R&D projects on arms control and disarmament that are now scattered throughout more than a half-dozen federal departments and agencies.

Moreover, the independent Arms Control Agency plans to expand greatly the scope of many of these projects and move into many areas that to date have been ignored or brushed over very lightly.

It is still much too early to estimate the size of the agency's program and budget for FY '63. However, an appropriation request of $100 million or more is considered by some government officials to be on the conservative side.

The agency is all but certain to request a supplemental appropriation in January for the rest of FY '62 since only $10 mililon was provided for the first year by the Arms Control and Disarmament Act that cleared Congress less than three weeks ago.

• **Sweeping power**—The authority granted to the agency to conduct R&D is extremely broad. It runs all the way from the possible development of missile deployment monitoring systems to studies on the political and economic effects of various types of arms control agreements.

One potentially important R&D program which the agency is certain to initiate quickly—it was mentioned specifically in the Arms Control Act—is the development of improved communications links between seats of government.

Such a project would be aimed at reducing the risk of nuclear war being started by error. It also would provide the essential means for ending a nuclear war.

So far, no determination has been made as to which of the many arms control R&D and study projects now under way will be transferred to the Arms Control Agency. The principal agencies involved are the Defense Department, Atomic Energy Commission, Central Intelligence Agency, State Department, NASA and Commerce Department.

The total amount being spent annually by these

ll Invest Many Millions in R&D

Project Vela Funding—*(in millions of dollars)*

	FY '60				FY '61				FY '62 (est.)			
	Uniform	Sierra	Hotel	Total	Uniform	Sierra	Hotel	Total	Uniform	Sierra	Hotel	Total
DOD	7.5	.4	.6	8.5	31.4	2.4	6.8	40.6	47	2	10	59
AEC	5.9	.2	1.2	7.3	13.4	.4	1.9	15.7	18	.3	2.1	20.4
TOTAL	13.4	.6	1.8	15.8	44.8	2.8	8.7	56.3	65	2.3	12.1	79.4

THE THREE VELAS: Uniform *is the detection of underground and underwater nuclear explosions;* Sierra *is the detection and identification by surface-based instrumentation of high-altitude explosions;* Hotel *is the detection and detonation by satellite-borne instrumentation of high-altitude explosions.*

agencies on arms control research has not been disclosed by the government because of security and the simple fact that no one apparently has ever added it up. But the total is estimated to run to more than $100 million—possibly as high as $130 million.

• **Biggest chunk**—Easily the largest of these projects is the Defense Department's *Vela,* the three-part program aimed at developing means of detecting and identifying nuclear explosions set off underground, under water and at very high altitudes.

Since *Vela's* inception in the fall of 1959, Congress has appropriated for it a total of $151.1 million. The bulk of this has been handled by ARPA, the rest by the AEC.

Vela is considered to be typical of the larger projects that the Arms Control Agency will undertake. However, because *Vela* is at a rather advanced stage, it is not generally expected to be transferred.

The Arms Control Agency is expected to award contracts for R&D projects directly to industry and private institutions, assign them to various government agencies and conduct some of them within the agency itself.

• **Organization**—William C. Foster, the industrialist and veteran government official whom President Kennedy named agency director immediately after signing the Arms Control Act, has made no decisions so far on how he will organize his staff. But the agency is expected to be organized generally along the same basic lines as the present Disarmament Administration that has been operating as part of the State Department.

The Disarmament Administration, which was established last fall, has three major divisions: A policy planning section, a political section and a projects and study section. It has operated under the direction of acting deputy director Adrian Fisher. Total staff: about 85.

Under the Arms Control Act, the entire Disarmament Administration automatically became the nucleus of the new agency, with Foster assuming the post of director.

Foster is expected to complete his organizational plans and lay down the agency's initial program within the next few weeks. To carry out the program, he is expected to increase his staff to about 250 over the next six months.

Most of the additions to the staff will be made in the projects and study section, or whatever division might take its place. Even today more than one-third of the agency is concentrated in this area.

However, under the old Disarmament Administration, the project and study section operated on an extremely limited budget. For FY '61, the entire Administration was authorized to spend only about $400,000.

• **Unarmed negotiators**—It was precisely because of this meager approach to arms control R&D within the State Department—and the scattered and disorganized approach outside of it—that the Arms Control Act received powerful support from many in the Kennedy Administration and Congress.

The feeling in the Kennedy Administration now is that when Foster comes in with his list of projects there will be little trouble in getting the money. ⌗

At IAC Stressing Peace—

Reds Tell of Titov's 'Seasickness'

Meeting attended by 600 from 27 nations largely ignores military implications of space exploration; other reports cover nuclear power, fuel cells, and materials

by William Beller

SOVIET SCIENTISTS disclosed in Washington last week that Maj. Gherman Titov was mildly "seasick" most of the time during his historic 17½ orbits of the earth on Aug 6.

This amplification of earlier reports that Titov had experienced "unpleasant sensations associated with his ear chamber" was virtually the only fresh information in papers presented by Russian delegates to the 12th International Astronautical Conference.

Despite reports of an impending new Soviet interplanetary space shot, the Russian visitors remained close-mouthed.

The Titov paper, by O. G. Gazenko and V. J. Yazdovsky of the USSR Academy of Sciences, said it appeared that the cosmonaut suffered nausea as a result of extreme weightlessness during most of the 25 hours he was in orbit.

Despite his discomfort, Titov kept a "sufficient level of working capacities at all times," the paper said.

As the flight went on, it reported, the unpleasant feeling worsened, particularly when the space man turned his head sharply. After he woke from his celebrated nap, the sensation eased steadily. But it did not disappear, the paper said, until the *Vostok* began to decelerate on re-entry.

"Thus," Gazenko and Yazdovsky wrote, "the sensation of some discomfort accompanied the considerable portion of the flight and resembled seasickness."

Their paper stressed that the flier was not seriously hampered by the condition of nausea, and that he was at all times able to carry out assignments.

Earlier official Soviet accounts told of Titov's difficulty with his inner ear while in a state of weightlessness, but did not elaborate.

The one other Soviet paper which came closest to new information was a 16-page effort entitled, "Some Results of the Constant Geomagnetic Field Measurements Carried Out from Sputnik III over the Territory of the USSR," co-authored by five Soviet delegates.

• **Accent on Peace** — The unannounced but clear theme running through most of the Congress' papers and pervading conversations in the corridors was preservation of space for peaceful uses. Significantly, there were no technical papers on subjects even remotely connected with military uses of space—such as reconnaissance satellites, missile trajectories or space photography.

The keynote was struck during the opening ceremony when IAF president Leonid I. Sedov, member of the USSR Academy of Sciences, was asked if his country and the U.S. could get together on launching large payloads. His reply: "I think it will be possible in the future, not only between the Russians and Americans but with other countries as well."

Hugh Dryden, deputy administrator of the National Aeronautics and Space Administration, added, "Sedov and I have discussed this possibility many times. If the decision were ours alone, there would be no problem."

More than 600 delegates from 27 different countries attended the technical and sociological sessions.

Even from a legal point of view, outer space was regarded as reserved for peaceful uses. Professor Alex Meyer, director of the Institute of Air Law and Space Law of the University of Cologne, averted that "it is nearly unanimously recognized that outer space, by its nature, cannot be subject to any sovereignty and is to be considered as a free area like the high seas."

• **Cosmic cold war** — Taking a broader—and more frigid—view of the cold-war situation, and extending it to other planets, Harold D. Lasswell, Yale University Law School and Graduate School, posed three eventualities should space explorers encounter extraterrestrial living forms:

—If explorers from a politically-divided world meet living forms of similar civilization in a similar predicament, extraterrestrial alliances will presumably be made—unless early contacts are multipartisan and gradual.

—If the newly discovered community is a dictatorship, it might not be eager to deal with its twin on earth and might swing toward the democratic bloc.

—If advanced forms of life have a superior civilization, they may treat earth with contempt and destructiveness.

In a technical paper, two Atomic Energy Commission scientists pointed out that nuclear electric propulsion will require extremely large amounts of electric power generated by machines having long reliable life and light weight. Specific weights in the 10-20 lb/kw range and lower will be needed to explore the solar system. Lt. Col. G. M. Anderson and Cdr. D. L. Jarrell predicted that "In our time, these can be achieved only by high-temperature Rankine-cycle or thermionic systems."

The *SNAP-8* nuclear power system will have either a 30-kw or a 60-kw electrical output at a specific weight in the 50-to-70-lb./kw. range. Jarrell said that the initial ground tests of this system are planned for 1962.

Giving a status report on the U.S. Army's fuel-cell work, Ernst M. Cohn of the Army Research Office said that it was largely one of basic and applied research rather than development. He complained that this was caused in part by the fact that some early private and government-sponsored development had to be delayed or discontinued when it became obvious that many chemical and material problems were still awaiting solutions.

Cohn admitted that several advances

had been made in fuel-cell technology. He listed among others:

—The concept of using a solid membrane instead of a liquid electrolyte—brought closer to reality when General Electric showed a 200-watt unit that works on hydrogen and air with cationic membranes as electrolyte.

—The year's most sensationally treated fuel-cell announcement — the biochemical fuel cell. Cohn said that while this concept is still in its initial stages and relatively few organizations are now pursuing it, the research already appears to be branching out into three distinct directions:

1) Attempts to imitate biological processes.

2) Possible *in vitro* use of biological materials as catalysts.

3) Use of primitive forms of life to decompose organic material and obtain fluid fuels suitable for use in fuel cells.

The problem of what materials to use in space, and where conventional materials fail, was reviewed by L. D. Jaffe and J. B. Rittenhouse of the Jet Propulsion Laboratory. They reported that studies show that cadmium and zinc platings will be lost through sublimation in space vacuum at those temperatures apt to be met in service. Metals such as aluminum and semiconductors such as germanium and silicon will not be appreciably affected.

They said that the vacuum behavior of high polymers must be treated in a different fashion because the large polymer molecules break down into volatile fragments.

Jaffe and Rittenhouse also brought out that: (1) friction and lubrication present a serious problem in the design of moving parts for space applications; (2) effects of solar ultraviolet radiation in space differ somewhat from those on the earth's surface because of the absence of oxygen—polymers are more apt to undergo cross-linking and accompanying hardening rather than fragmentation and softening; and (3) the surfaces of organic materials and glasses can be very seriously damaged in the radiation belts.

An interesting description of the moon's surface emerged from some lunar eclipse observations analyzed by John E. Gibson, U.S. Naval Research Laboratory. He said they seemed to indicate the topmost layer of the average lunar surface has thermal and electric properties that might apply to a loose granular substance like dust or sand. Underlying this top layer at a depth of perhaps a half centimeter is a substratum having higher electric conductivity—somewhat like that of the heavier terrestrial soils. The deep subsurface seems to resemble rock. ⌗

Vice President Briefed At Ames and Edwards AFB

by Richard van Osten

LOS ANGELES — Problems facing *Apollo* designers were laid out for Vice President Lyndon B. Johnson by NASA's Ames Research Center scientists and engineers last week.

The Vice President was told that midcourse guidance by pilot input to a computer-type system will be required to place the vehicle within a six-mile initial point envelope in order to set up the desired lunar trajectory. Present calculations indicate that the average miss distance for a lunar target point landing is not likely to exceed two miles, with the human-corrected guidance concept.

The re-entry corridor for *Apollo* earth return at about 25,000 mph is a bit broader—40 miles between the upper limit, where air density is insufficient to permit proper deceleration, and lower limits where the air is too dense. The equivalent entry corridor for the *Mercury* capsule is eight miles deep.

At re-entry, the *Apollo* vehicle will generate about two times as much heat energy as *Mercury*. Calculated heat is about 30,000 B.T.U. per pound of vehicle weight. *Apollo* will be subject to both convective and radiative heating. An ablation-type shield will probably do the job, Ames scientists told the Vice President.

• **"Moonstones"**—Radiative heat is difficult to simulate, but Ames is having considerable success with a reflected carbon arc system and very small models. Dr. Dean Chapman showed some small tektites, or "moon marbles"—glass-like materials found in Australia. He said much could be learned about the heat requirements for *Apollo* from the tiny "stones," believed to be from the moon, by scientific study of their character and temperatures to which they were subjected.

They are not the same as meteorites, Chapman said.

At the Ames space physics section, Johnson heard a brief outline of work in ion acceleration. The section is working on studies of the erosive effect of ions on surface coatings of materials, and is developing a solar radio emission receiver.

Ames also developed the low-energy proton analyzer on *Explorer XII* which, according to Dr. Alfred J. Eggers, Jr., is so oriented at the present time that the proton analyzer is faced away from the sun and is recording only background noise. It will eventually turn around and pick up the sun. Data obtained will be vital in determining when conditions are undesirable for space missions due to solar flares.

Time prevented a complete briefing on Ames work, but the Vice President expressed extreme interest in the work in progress. He was accompanied by Rep. George Miller (D-Calif.), newly appointed chairman of the House Science and Astronautics Committee.

• **Look at X-15**—Flying to Edwards AFB later in the day, Johnson heard a briefing on the *X-15* program and other NASA projects at the site.

The basic *X-15* program is moving into its final stages. A 200,000-ft. altitude attempt is scheduled for this week, and a 4000-mph speed run will be attempted in about two weeks.

There will be more testing of the reaction controls, which have not been put into full use yet because of the relatively low altitudes of *X-15* operations. An advanced control system is being installed in one *X-15* and will be flown in about two weeks.

Other programs planned for the *X-15*, in addition to advanced controls development, include structural research, celestial photography and other space sciences. Highest temperature recorded on *X-15* flights to date is 1050°F at a point on the lower fuselage.

Work is also under way at Edwards on the *Dyna-Soar* escape system for ground abort of a mission. NASA Pilot Neil Armstrong demonstrated the approach with the NASA A5D by making a low pass at about 1000 ft., pulling up to a vertical position and cutting power, rolling out level and landing power-off on the nearby runway.

The A5D closely simulates some general characteristics of the *Dyna-Soar* vehicle.

NASA personnel also commented on the Rogallo Wing concept of booster recovery, pointing out that a one-quarter-scale *Mercury* capsule has been recovered from 10,000 ft. with a development model.

The Vice President also visited Jet Propulsion Laboratory and Vandenberg AFB.

This was the first of Johnson's "listen and learn" trips, as he calls them. He is looking for problem areas in an attempt to determine if everything that should and could be done is being accomplished in the space programs.

The only problem he noted after his first-day tour was NASA's apparent difficulty in retaining personnel who move into industry for higher pay. He offered no immediate solution. ⌗

U.S. Set To Press Rendezvous Approach

Lunar planning also calls for continuing development of Nova booster, in case direct flight is necessary

by Hal Taylor

THE KENNEDY Administration is expected to announce in the near future a decision to push "orbital rendezvous" as a main U.S. avenue to achieve a manned lunar landing.

Development of a large *Nova* launch vehicle—prime booster for a direct flight to the moon—will also continue. If rendezvous proves to be feasible, *Nova* development will be considerably slowed or perhaps even dropped. A final decision will not be made for a year.

NASA Administrator James E. Webb said last week that "we will probably use the rendezvous concept." He estimated that if it works it could cut as much as two years off the timetable for a manned U.S. lunar landing.

Informed sources also report that the joint NASA-DOD committee set up to make recommendations on future U.S. space programs fully supports rendezvous and will recommend its development to President Kennedy.

Dr. Hugh L. Dryden, deputy administrator of the space agency, said in an interview that the new impetus for the rendezvous program will begin with a NASA program which will attempt to mate a *Mercury* capsule to an orbiting *Agena B* launch vehicle. The experimental program in rendezvous will begin shortly, he said.

The early experiments, Dryden explained, are intended to determine whether the basis for the rendezvous concept of space flight is sound—that is, can two space vehicles be joined together while orbiting in space.

• **Bigger booster backed** — Dr. Dryden also said that support for a four-F-1-engine version of the *Saturn* as a booster for possible future rendezvous flights in the moon program "has also stepped up."

The support for a larger booster than the currently planned *Saturn C-3*, with two F-1 engines, stems, he said, from the logistics requirements of the rendezvous operation. The *C-3* would require several launches to complete the rendezvous mission.

A majority of the joint NASA-DOD committee also favors a larger booster than the *Saturn C-3*, and leans toward the four-F-1 engine configuration.

The new support for rendezvous is based on two considerations:

1. Less reliable launch vehicles could be used to put the materials for a manned lunar landing attempt into orbit; more reliable vehicles could be used to put the astronauts into orbit where the rendezvous could take place. This means that when the U.S. is ready for the lunar shot, the comparatively new *Saturn* with two or four F-1 engines could be used to place the materials into orbit. The *Saturn C-1*, with eight H-1 engines—which by then will have three or four years of testing—could put the astronauts into orbit.

2. Rendezvous would cost about one third less than a program utilizing direct flight to the moon with the multimillion-lb.-thrust *Nova* booster. An NASA official has estimated that it will cost some $6 billion to develop the large *Nova* booster, including launch facilities. The cost per launch with the *Nova* is set at $100 million—or $10 billion for 100 launches. A total of $16 billion is seen for the whole program.

The costs of rendezvous are estimated at: $1 billion to develop the rendezvous technique; $1 billion to bring the *Saturn* vehicle to operational level and build launch facilities; $9 billion for 100 launches. Total: $11 billion.

• **Alternatives**—The types of rendezvous under consideration include:

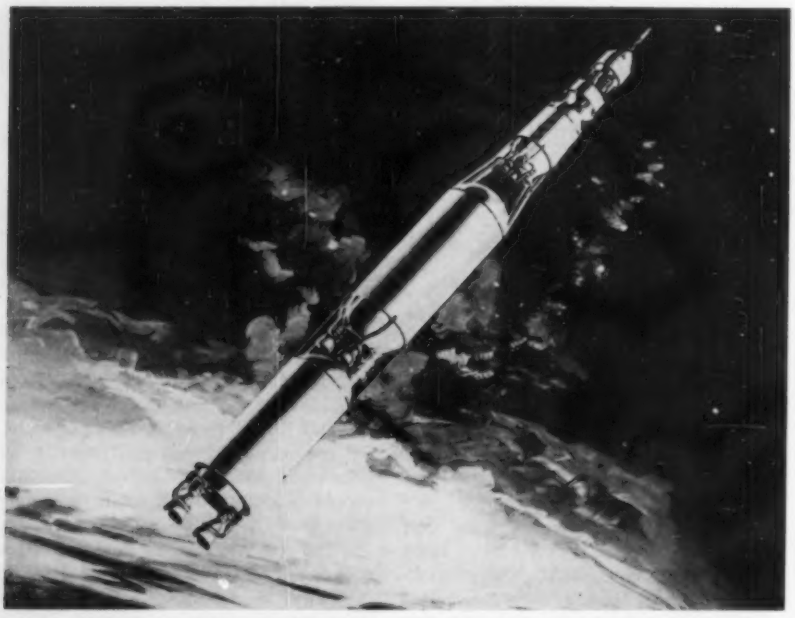
—300-mile orbit, with two vehicles put into that orbit and an attempt made to join them.

—Send one vehicle to a 300-mile orbit and another to 150-mile-high orbit. The vehicle at the lower altitude would then fire again and be launched to the higher altitude, where it would couple onto the other vehicle.

—Send a man on a direct flight to the moon; then send another vehicle to the moon which he would use to return.

—While a large spacecraft orbits the moon, another smaller one would break off for the flight to and return from the lunar surface.

A good bet for a possible manned moon shot from the rendezvous concept is the 300-mile earth-orbit position. ⌗



NASA CONCEPT of the Saturn C-3 with two F-1 engines in flight. Support for four-F-1-engine version is growing, and there is a good chance it will replace the C-3.

After sharp attacks . . .

NASA Revising Patent Law Proposals

HEATED INDUSTRY opposition is forcing NASA to revise its proposed patent licensing regulations.

Gerald D. O'Brien, NASA's top patent official, admits that the size of the industry opposition was unexpected.

Industry representatives and patent lawyers attending recent public hearings were unanimous in their opposition to the regulations which would give the space agency the right to charge a fee for the use of NASA-owned patents—and also give firms exclusive use of such patents, in certain situations.

O'Brien also admits industry opposition will force some revision in the regulations. But, he says, "it is still too early to tell to what degree, or whether any major sections will be dropped."

The NASA official said it would be at least six months before a report is prepared on the public hearings, and some time after that before recommendations are made to NASA Administrator James E. Webb.

Meanwhile, there were these other developments in the government patent fight which has raged for the last two years:

—The National Space Council—the President's space advisory group—announced it is drawing up a uniform patent policy to cover inventions stemming from developmental work on communications satellites.

—Hopes for legislation to set up a government-wide patent policy have been revised slightly by promises of further action during the next session. Sen. John L. McClellan (D-Ark.), chairman of the Patent Subcommittee of the Senate Judiciary Committee, said as the current session ended that such legislation will be enacted next year. The House Space Committee also announced it will hold more hearings in December on legislation which would give NASA greater leeway in waiving the right to patent ownership.

• **Precedents lacking**—Most of the current controversy, both in Congress and the executive branch, stems from NASA's unique position in the "patent scheme of things." Only the AEC has a more stringent patent setup.

Under the National Space Act, the agency has the right of ownership to any patents accruing from inventions made by contractors in the performance of research and development contracts.

If the contractor requests it, the space agency can waive its right of ownership. Title to the patent then goes to the contracting firm.

If no request is made or if the request is refused, ownership is retained by NASA.

Such NASA-owned patents have been piling up and the space agency, on July 15, proposed licensing regulations to put them to use:

—If the invention was developed by a NASA R&D contractor, the space agency could grant him a royalty-free, non-exclusive, non-transferable, and revocable license.

—Any other firm could get the same license to use the patent, but a fee would have to be paid to NASA for its use.

—If a firm could prove it needed protection from competition while putting a patent into commercial production, NASA could grant an exclusive right to use a patent on which the firm would have to a pay a royalty.

• **United attack** — Industry opposition at the agency's public hearings was vociferous and unanimous.

Industry representatives included Charles L. Shelton, Aerospace Industries Association; A. L. Bain, National Security Industrial Association; Joseph Grey Jackson, American Bar Association Patent Section; K. S. Wyman, Allis-Chalmers Manufacturing Co.; Elmer Gorn, Electronic Industries Association; and T. M. Ferrill, National Association of Manufacturers.

Their opposition was based on three major points:

—NASA should not charge royalties for the use of government-owned patents.

—The cost of administering the licensing program would exceed fees obtained through the royalty system.

—There is some question as to whether executive agencies have authority under the Constitution to enforce a patent-licensing system or to give exclusive rights to a government-owned patent.

While the licensing regulations received most of the industry fire, the space agency's unique "patent ownership" rights also were attacked. U.S. industry would like that section of the space act changed to bring it more in line with Department of Defense patent policy. In dealing with that department, the R&D contractor has the option to take out a patent on any invention. If he does not, DOD then can take ownership. The military agency also permits anyone to use a DOD patent without obtaining a license.

Shelton charged that "NASA patent ownership rights substantially reduce any incentive a company might have to perform research and development for the space agency."

• **Congress to dispose** — NASA this year did not take a position on legislation before the House Space Committee which would have changed its ownership rights to reflect the DOD system.

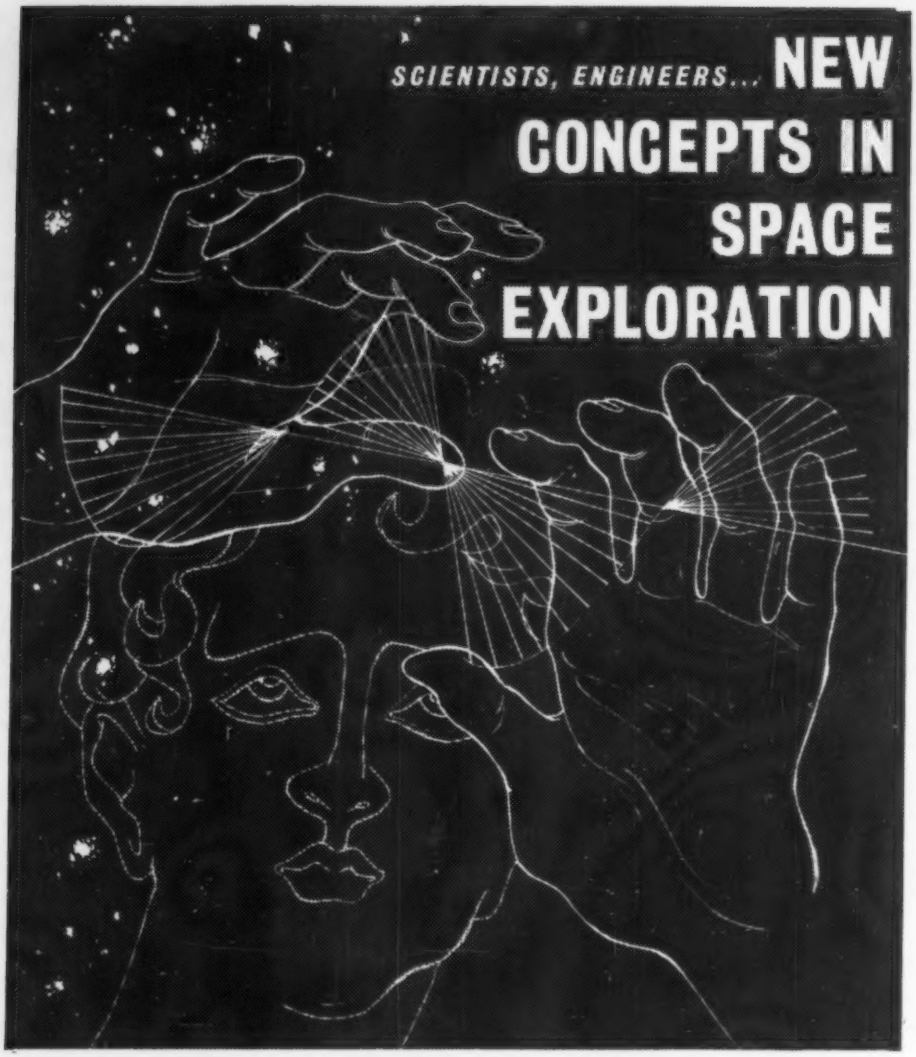
NASA said it was waiting for a government-wide patent policy to be formulated. Shelton charged that NASA's failure to take a position on the legislation stemmed from a feeling that its current ownership rights should not be repealed because it is not encountering as much difficulty in getting contractors as it anticipated.

A settlement of NASA's patent dilemma probably will depend upon the passage of legislation establishing a government-wide policy. While Sen. McClellan has promised to push such legislation in the next session of Congress, a rough road lies ahead.

Differing bills have been introduced in the Senate. One would give to the government the ownership rights on all patents arising from R&D contracts. Others would give most ownership rights to industry, permitting the government to take title in a few areas.

Although Congress has asked executive agencies to come up with recommendations for a government-wide policy, none has been forthcoming. A committee in the Commerce Department which was set up to do the job held only one meeting about two months ago.

• **Council passes** — Some officials have expressed the hope that the space council's formulation of a patent policy on communication satellites can serve as a guide for over-all government policy. This is dispelled by council officials, who assert that their only job is to clear up the communication satellite controversy. ⌗



at RCA'S Astro-Electronics Division
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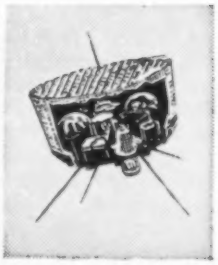

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Technical Countdown

ADVANCED MATERIALS

Soviets Looking into High-Energy Forming

An explosive-type ram impact machine, designed by the Khar'kov Aviation Institute, is being used to study the plastic behavior of metals. One recommendation flowing from this original research is that explosive-forming installations should be developed in the USSR. The maximum amount of deformation in hot upsetting was investigated for carbon and alloy steels, titanium alloys, aluminum alloys and ". . . hard-to-form heat-resistance alloys."

Silicon Nitride Space Coating

Air Force researchers are using thin films of silicon nitride to protect components from temperatures up to 900°F. The coatings are non-conductive at high temperatures. In one instance, a condenser functioned perfectly after remaining for 400 hours at 932°F. The film is capable of preventing metallic oxidation at much higher temperatures.

LIFE SUPPORT

Radiation Studies Use 'Plastinauts'

The AF's Special Weapons Center is performance-testing three man-size "plastinauts" as a unique research instrument for the study of the biological effects of space radiation on man. The artificial human figures—designed to fly in any space vehicle which can carry a man—are made of a plastic which absorbs radiation in much the same way human tissue does. In fact, this plastic "flesh" reportedly has the same atomic make-up as the human body.

SUPPORT EQUIPMENT

Titan II Gets Propellant Transfer Units

Propellant Transfer Control Units—designed to deliver Aerozine 50 or nitrogen tetroxide from storage tanks or trucks to the *Titan II* first and second stages—are being delivered by Hamilton Standard, a division of United Aircraft Corp., to The Martin Co. for use in the missile R&D program. The 12,000-lb. GSE units are completely self-contained and require only 440v, 60 cps power for a transfer capacity of 61 or 190 gpm at pressures over 100 psig.

Mobile Cranes Ease Base Construction

Fragile and very costly pressure vessels for dual storage at the 12 *Atlas* sites throughout the country are now being moved more safely and economically by rubber-tired cranes. Equipped with solid-support outriggers operated from the cab by hydraulic power, the cranes—designed and manufactured by the Thew Shovel Co.—are capable of speeds up to 35 mph.

Garrett Extends GSE Line

Product line extensions into the storage, transportation and pumping of cryogenic fluids for GSE applications are in the works at Garrett's AiResearch Mfg. Division. J. Connell will manage the new operation. No site has been announced. Products will include cryogenic recharger vehicles, storage tankers, vaporizers, high-pressure pumps, couplings and samplers.

ELECTRONICS

Research Leaders Polled by DOD

Communications and command control systems rate highest priority in current research by the electronics industry. This is contrary to the widespread opinion that electronic-component reliability studies top the list. The conclusion is based on opinions of 49 industrial, academic and government electronics authorities polled by the Defense Department to determine most significant areas of current electronics research. Two top items of emphasis in the components field are solid-state and laser research.

SD-5 Guidance Tested

The Army's new *SD-5* high-performance drone successfully completed its 13th flight last week, using an all-inertial guidance system for the first time. The Mach 0.7 reconnaissance jet is undergoing final development for the Signal Corps by Fairchild Stratos Corp. Minneapolis-Honeywell developed the inertial system. Flown over the Drone Test Range between Yuma and Fort Huachuca, Ariz., for almost two hours, its photographic system also was tested successfully for the first time. In its final form, the drone will be capable of transmitting all observed data to ground, either periodically or upon ground command.

Package Cooling Studied by Army

Placing auxiliary thermoelectric cooling units in the walls of electronic packages can result in a significant increase in the size limits of the packages cooled by thermal conduction, according to a report recently released by the Army. The study of methods of cooling densely packaged electronics was based on a comparison of three types of cooling: simple conduction, thermoelectric (Peltier) effect, and a combination of the two. Findings indicated that the package structure can cool large units by thermal conduction through the structure members, with commensurate increases in package sizes and volumetric heat-release rates.

Pacific Mercury Tracking Bats .667

Two of the three Project *Mercury* Pacific area tracking stations reported contact with the recent *MA-4* (orbited capsule with robot passenger) launch. PMR ground stations at Canton Island and Pt. Arguello, Calif., recorded telemetry transmissions from the capsule for over 7 and 4 minutes, respectively. The newly operational $7-million installation at Kokee, Hawaii, missed the capsule because the vehicle flight path was too far south. Kokee did serve, however, as a communications station in world-wide *Mercury* net.

Zeus Carries Dual-Destruct System

Nike-Zeus' automatic destruct system, an Army spokesman revealed last week, begins operation 5 seconds after launch and remains in operation for 11 sec. The safety system used in the recent *Zeus* test launch from Pacific Missile Range was programed by an IBM-709 computer using inputs from a *Zeus* Missile Tracking Radar (MTR), a cosine tracking radar (COTAR), and an FPS-16 tracking radar. The system complements a manual ground-command destruct system controlled by the Range safety officer.

Mercury Reaction Controls Revealed

Bell-developed 'piloting' system described— company working on bipropellants for advanced vehicles

by John F. Judge

BUFFALO, N.Y.—Details of the *Mercury* reaction control system—the astronaut's "piloting" apparatus—have been disclosed by Textron's Bell Aerosystems Co.

The system, developed by Bell under contract to McDonnell Aircraft Corp., governs all capsule orientation while in space. It can be either automatic or under the direct control of the astronaut.

Bell experts have already gone far beyond the *Mercury* monopropellant system. Research and development in bipropellants for more advanced space vehicles is in high gear at the firm.

The experience gained during the *Mercury* system development will contribute a great deal toward any second-generation reaction control system.

Bell reaction controls are also employed in *Centaur*. The company is in the running as a major producer of secondary propulsion systems to be used for vehicle orientation and attitude control, as well as ullage and separation devices.

• **Flexible system**—The capsule reaction control is a pressure-fed system incorporating right-angle-firing thrust chambers. Regulated helium pressure on the bladder-type monopropellant tank supplies concentrated H_2O_2 to the catalyst beds, where rapid decomposition occurs.

The system is broken down into two subsystems, which can operate separately or together. There is an electrically controlled automatic subsystem and a manual subsystem capable of hand or electrical operation.

Two thrust modes in the automatic subsystem handle pitch, yaw and roll attitude. High thrust delivers a nominal 24 lbs. in the pitch and yaw attitudes, and a nominal 6 lbs. in the roll attitude. The low-thrust mode consists of chambers delivering a nominal 1-lb. thrust in the three attitudes.

The manual subsystem provides vehicle control in the high-thrust mode when electrically operated (rate stabilization mode). Variable thrust of 4 to 24 lbs. in pitch and yaw, and 1 to 6 lbs. in roll, is provided when the subsystem is under manual control.

Operating principles are essentially the same for both subsystems. A 2250-psig helium source pressure is reduced to 480-485 psig through a regulator and applied to the subsystem's 9711 Silastic bladder, expelling peroxide from the toroidal tank into the propellant feed system.

The propellant decomposes on contact with the catalyst bed, generating steam and free 0_2 to produce thrust. Direction of flow through the manual throttle valves, or the solenoid-operated valves in the manual system, is controlled by a manually operated selector valve.

• **Chamber components**—The thrust chamber assemblies include:

—Propellant inlet valves—the unit which checks or controls the propellant flow to the decomposition chambers. The automatic system's inlet valves controlling high and low torque pitch and yaw control are coaxial flow, solenoid-operated, on-off valves.

The high and low torque roll control unit is a dual-thrust chamber assembly with 6- and 1-lb. components on a common mounting flange. Each has its own solenoid-operated on-off inlet valve.

Manual pitch and yaw involves a 24-lb. thrust unit with a spring-loaded check valve. This is used in conjunction with a manually operated throttling valve in the proportional control mode, or a solenoid on-off valve in the rate stabilization mode.

The manual roll control is again a spring-loaded check valve used in conjunction with a manually operating throttling valve in the proportional modes or a solenoid on-off valve in the rate stabilization mode.

—A heat-barrier tube which feeds the propellant from the inlet valve to the decomposition chamber. The small-diameter, thin-walled tube thermally insulates the inlet valve from the heat generated as a result of decomposition, keeping the valve and the upstream propellant at a tolerable temperature during the duty cycle.

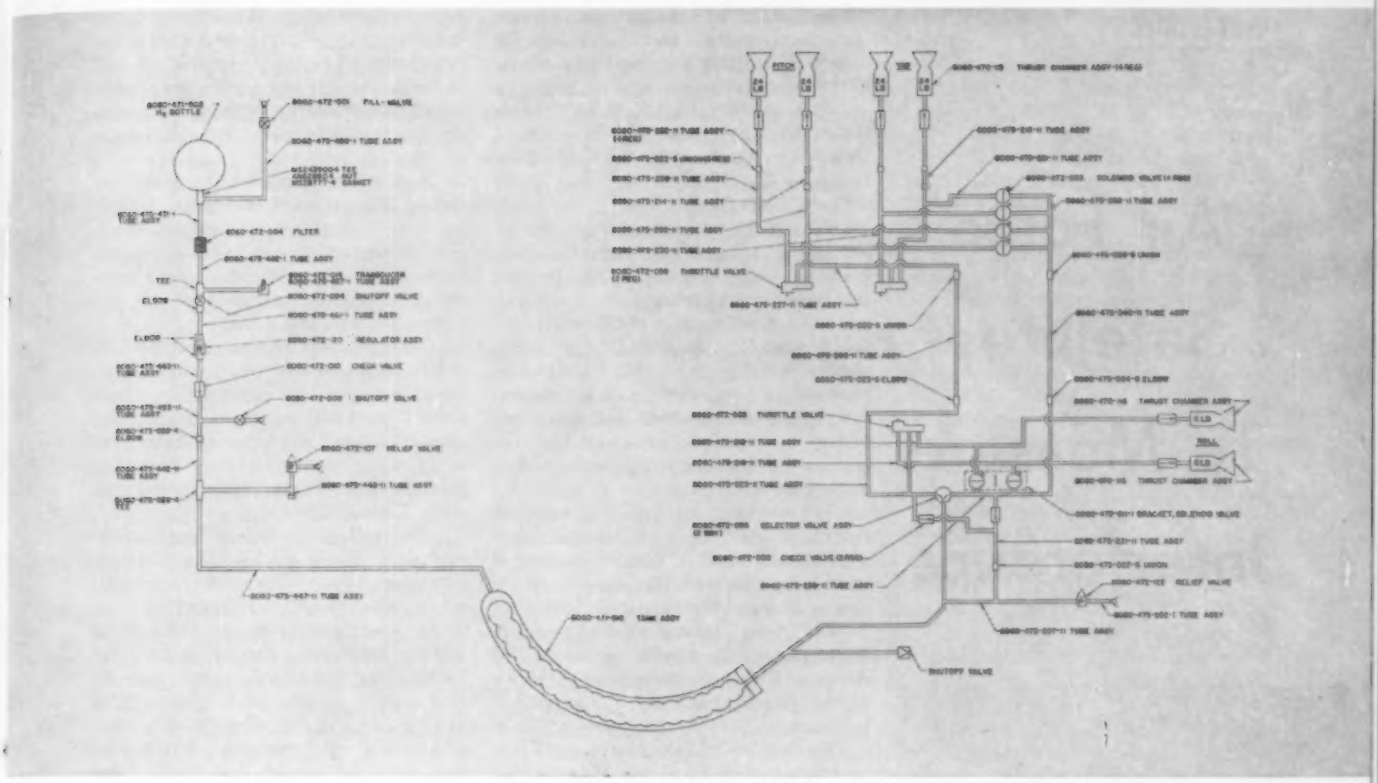
—A trimming orifice, located between the heat barrier outlet and the decomposition chamber, compensates for random variations of the overall pressure drop through the assembly. This insures rated thrust output at a rated propellant feed pressure.

—The decomposition chamber houses the catalyst bed and contains the high-temperature decomposition products. The bed assembly consists of nickel wire-mesh discs plated with a silver alloy. These are stacked into thin-walled, stainless-steel retainer cups, four to six in each chamber.

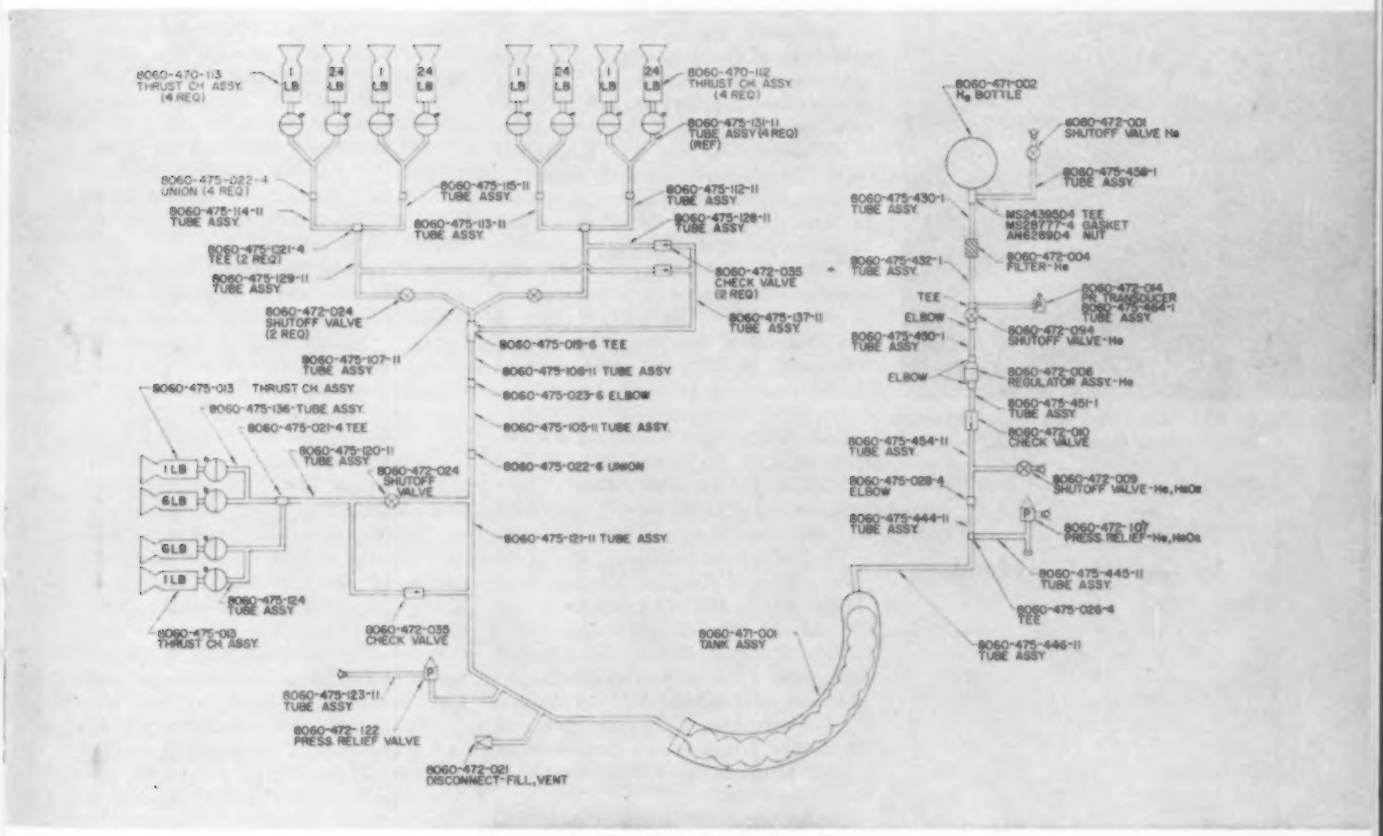
The upper lip of each cup, under axial load, provides a seal on the chamber wall, preventing propellant by-pass. The propellant is forced by inlet pressure into intimate contact with the large catalytic screen surface. Peroxide breakdown is triggered by an exchange of free electrons in the silver crystal lattice with the H_2O_2 molecules, and then sustained by the thermal energy release of the exothermic decomposition reaction.

All of the peroxide is ultimately decomposed to an oxygen-superheated water mixture which exits through the nozzle.

The *Mercury* system is completely engineered for the particular job at hand. Bell engineers have found that off-the-shelf items seldom fit into such a system without modification. The *Mercury* system has revealed the problem areas that might be encountered in any future system. ⌗

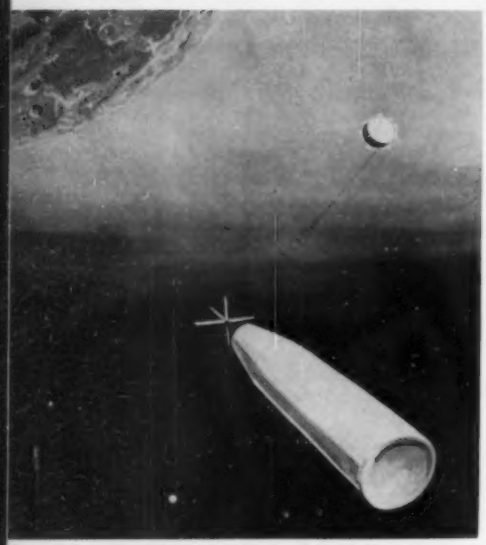


Manual Reaction Control System



Automatic Reaction Control System

Air Force Satellites To Measure Interference



ARTIST'S conception of the Armour-designed interference-measuring satellite.

by Charles D. LaFond

A SERIES of electromagnetic interference-measuring satellites will be placed in orbit by the Air Force beginning late in 1962.

Blue Scout (HETS 109A) solid-fueled launch vehicles will be used to locate the 300-lb. spin-stabilized space packages in orbits at altitudes from 100 to 1000 miles.

Aim of the program is to determine the amplitude and spectrum characteristics of man-made radio interference that will be encountered by electronic systems operating in high-altitude aerospace vehicles. To assure that completely reliable navigation and communication equipment is available for future manned satellites and space vehicles, it is essential to know the frequency distributions and power densities at various altitudes.

The problem to date has been to determine the parameters and develop a practical automatic spectrum-analyzer system for use in an unmanned satellite that will accomplish the task.

All of the initial studies and breadboard designs have been performed by Armour Research Foundation (ARF) of the Illinois Institute of Technology in Chicago.

Sponsor of the program is the Communications and Electronic Department, Aeronautical Systems Div., AFSC, at Wright-Patterson AFB, Ohio.

• **Project status** — Two contracts have been awarded to ARF. The first, for $144,000, was started in May, 1959, to determine the high-altitude interference parameters, to develop measurement techniques, and to design and build a breadboard prototype system.

Initially, measuring equipments were considered for use in space up to 1000 miles altitude over the frequency range of 75 kc to 75 gc (kmc). Use of both satellites and balloons was considered.

As a result of the early studies, it was determined that the range above 100 miles be explored, that a spin-stabilized satellite be used, and that selected radio frequencies be explored.

AF design requirements set a maximum of 2 cu. ft. volume and 100 lbs. weight for the instrumentation. These limits excluded power supply, command and telemetering equipment.

The complete instrumentation canister size was fixed at 300 lbs. total weight and a 3-ft. diameter to fit the lift and size capability of a *Blue Scout*.

The first contract was concluded in September, 1960; a second, for $429,384, was awarded to ARF last August.

The new project will concentrate on microwave frequencies encountered at orbital altitudes, and will consist of two main tasks:

—To study instrumentation techniques and later build breadboard equipment to measure electromagnetic interference at selected frequencies over the range of 1.7-17 gc.

—To study and provide recommendations covering methods for measuring r-f interference over the ranges of 17-35 gc and 35-80 gc.

Selected ranges to be covered by the ARF breadboard system are 1.7-2.3 gc, 4.0-6.0 gc, 8.0-10 gc, and 10-17 gc. The system will be designed to provide automatic frequency scanning and automatic amplitude control in an unmanned orbital test vehicle.

This portion of the spectrum requires increased emphasis, according to the Air Force, because of the trend toward increased use of the higher frequency bands for communications and other electronics systems. Also, these frequencies cover the whole radar range from L-band upward.

The influence of such high-power stations as those employed in BMEWS (Ballistic Missile Early Warning System) certainly will warrant study.

A third contract, to build the actual satellite hardware for studying the lower frequencies, will be awarded, the Air Force says, in the next few months. How many systems will be built has not been announced; however, it is known that only one satellite will be used for the lower-frequency study.

For studying the microwave frequencies, several satellites probably will be employed. It is possible, said one AF spokesman, that many more satellites will be used for selected frequencies at the upper end of the spectrum.

The Air Force has been trying to schedule the first launch within the first half of next year, but it appears now that the earliest possible date will be late in '62 or early '63.

• **Prototype hardware** — In its first study of the whole problem, ARF scientists considered five principal interference parameters as a function of orbital vehicle spatial position and time of measurement:

—Directions of signal arrival.
—Polarizations.
—Signal amplitudes.
—Frequencies.
—Types of signals or modulations.

The first was determined to be impractical for several reasons. Determination of direction would require a highly directional antenna—that is, one responsive to a hemispherical zone below the horizon. Also such a system would require broad-band coverage and rapid identification of signal direction.

Further, two or more signals present in the bandpass of the receiving equipment would result in a composite signal. Finally, directions of incoming signals might be altered considerably due to refractions, reflections, and scat-

tering over the propagation path.

The second parameter was found equally impractical. Signal polarization cannot be measured properly without establishing direction of arrival. Vehicle size-weight limitations and the problem of composite signals are handicaps.

As for identification of signal modulation, detection would require monitoring durations compatible with the modulation bandwidths. The result, ARF believes, would require a sacrifice in collecting rates for amplitude and frequency data. It was decided, then, that modulation characteristics would be obtained only when there might be no significant decrease in spectrum data collection rates.

Thus, the final parameters deemed essential for measurement are frequency and amplitude level, along with spatial position and time.

The final system evolved was comprised of a program computer for system control and digital data analysis and readout, five receivers—four octave-coverage receivers, an information storage unit, and an antenna system.

Three receivers were designed to scan the frequency octaves of 4-8 mc, 8-16 mc, and 16-32 mc by means of a stepped-frequency and i-f gain procedure using voltage-tunable inductors (Incroductors). An electronically swept, tuned superheterodyne receiver was built to cover the 120-180 mc range. Finally, an alternate-reception unit was designed for receiving two fixed microwave frequencies at 1010 and 2200mc. An overall amplitude measurement range of 90 db was achieved.

Data readout is in digital form and magnetic tape storage is employed for periodic telemetering of collected information to ground stations.

Each receiver covers its octave range in a series of 128 discrete steps, each step 1 msec. long. A seven-digit binary code associated with each step is used for frequency identification.

After frequency stepping at one gain level, receiver gain is stepped sequentially 6 db at a time for 16 different gain levels. This achieves spectral exploration of signal strength versus frequency. A four-digit code is generated for designation of signal levels.

Following each step, video is observed at the receiver detector output for about 0.9 msec. The presence or absence of a signal at the reference amplitude level is determined and a pulse is produced if the video exceeds reference gain level. These data are recorded while the next step is under observation. Thus, ARF says, about 95% of receiver sampling time is used for signal observation.

Following data recording from the first receiver, the programer switches the antenna to the next receiver. Also, video sampler output of that receiver is connected to the recorder and plate power is applied to it.

For sequential transmission to ground, 13 telemetry subcarrier channels will be required for the observed data. ARF has suggested use of an FM/FM multiplex system operating in the 216-235 mc band.

Antenna physical design limits required with use of *Blue Scout* were: 15 lbs. for the antenna and erection equipment; capability for containment in a 24-in. dia. cylindrical vehicle and within 1.5 cu. ft. total volume.

For the 4-32 mc range, an unfurlable log-periodic dipole array was designed as a part of the initial study.

For the higher range (100 mc to 4 gc), a non-planar unfurlable version of a log-conical spiral was selected.

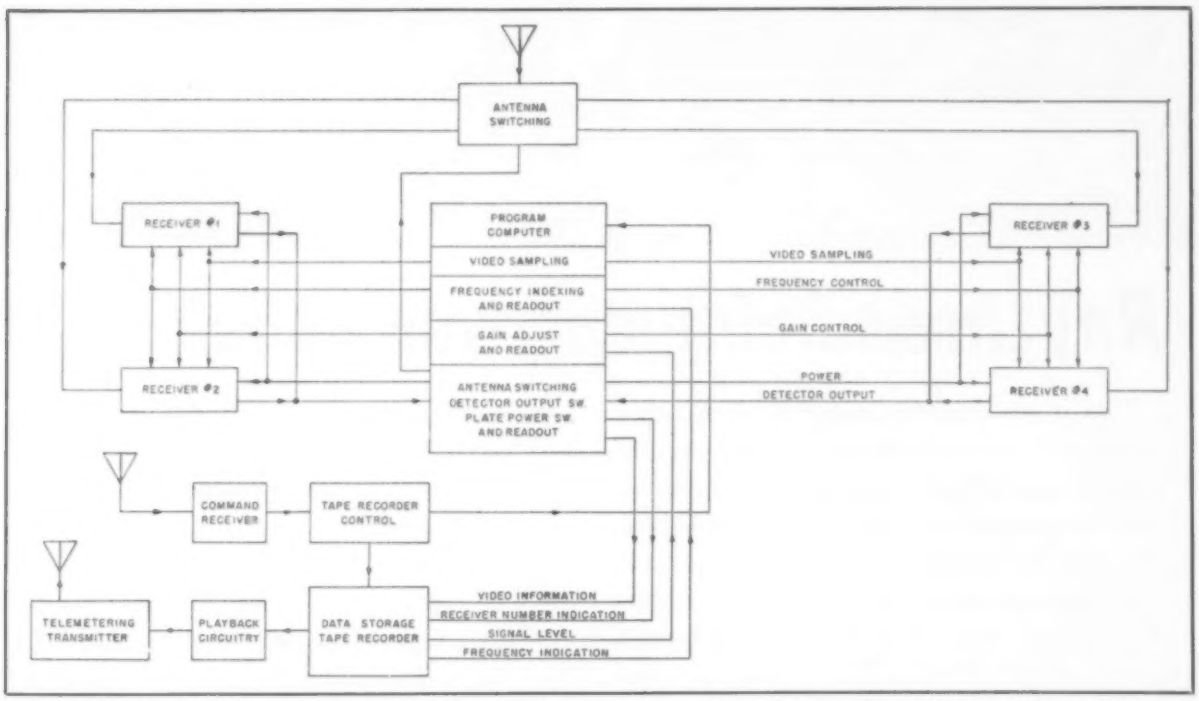
However, both of these can only be used with an advanced launch vehicle of the future.

For use with the *Blue Scout* system, a less efficient orthogonal array of three small electric dipoles was suggested, as a compromise.

This would be an omnidirectional antenna, insensitive to vehicle spin.

Dipoles are 29.5 in. long overall and the satellite casing itself forms a part of the array. To permit furling, dipole elements would be made of stressed aluminum ribbon. The exact configuration for this antenna remains to be determined.

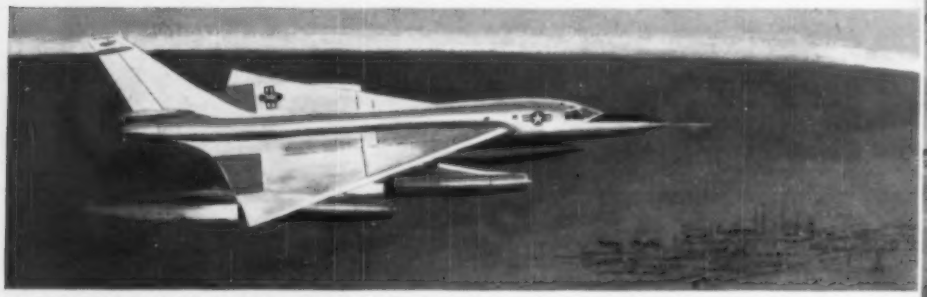
For the future, ARF believes the prototype instrumentation proves feasibility of the program. Actual satellite hardware, it asserts, can be miniaturized readily, but it believes that only two receivers might be used initially for the 100-180 mc and 275-400 mc range. With these frequency ranges, size-weight limitations can be met easily. ⠿



BLOCK DIAGRAM of proposed interference measuring system showing sequential operation of four receiving channels.

NAVIGATION — Raytheon in 1958 developed a highly sophisticated Doppler Navigation System for the U.S. Navy's A3J. This system was the forerunner of an advanced Raytheon Doppler System now operational in the U.S. Air Force's B-58.

TERRAIN AVOIDANCE — Raytheon designed and is producing the U.S. Air Force's only operational low-altitude target acquisition radar. It is currently installed on the Strategic Air Command's B-52 intercontinental bomber.



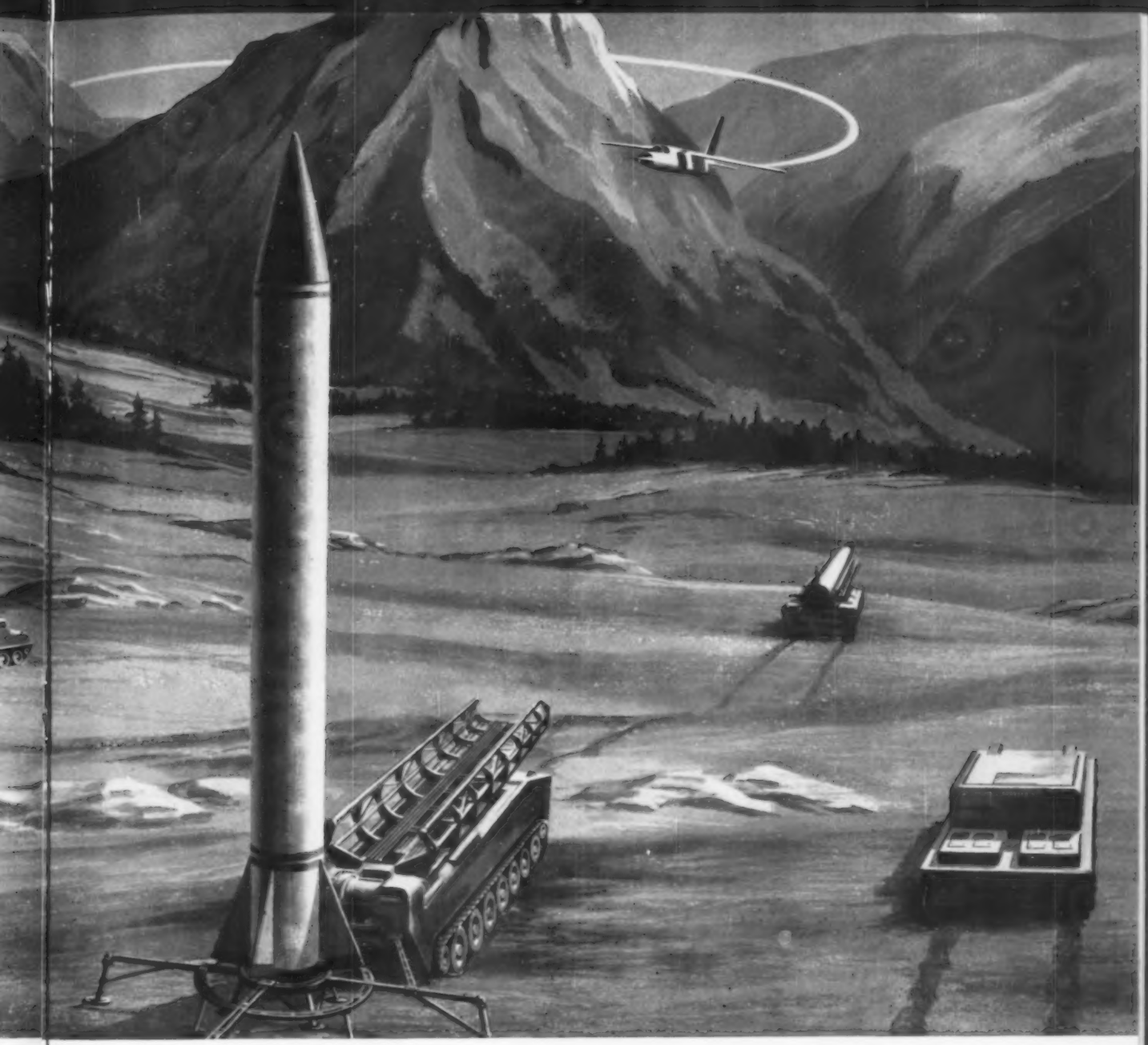
BOMB-NAVIGATION SYSTEMS — Raytheon developed and produced an integrated radar-radome for the high performance B-58. With the Raytheon Doppler System (the most accurate in use today, despite severe environmental conditions) these radars are vital elements of the Hustler's bomb-navigation system.

Raytheon brings proven capability to t

Experience and achievements give ample proof of Raytheon's ability to develop and produce operational equipments that would enable high-performance aircraft to carry out the deep penetration-low altitude attack mission: ■ Raytheon Doppler navigation radars for the A3J and B-58 ■ Raytheon terrain avoidance radars for the B-52 ■ Raytheon bomb-navigation radars for the B-58 ■ Raytheon low altitude guidance systems for interceptor missiles.

Add to these Raytheon's selection as prime contractor-systems manager for the U.S. Army's and Marine Corps' HAWK and the

Circle No. 6 on Subscriber Service Card



o the low altitude attack mission

U. S. Navy's SPARROW III missile systems; as producer of the 2nd generation Polaris' advanced guidance system; and as systems manager of the ARPAT Terminal Defense System program.

One of the world's largest scientific-industrial organizations, Raytheon can create the required technology and manage every phase of a complex defense or space system — from early study and design through development, production and field support of operational systems and equipment.

Missile and Space Division, Bedford, Massachusetts.

RAYTHEON COMPANY

MISSILE AND SPACE DIVISION

RAYTHEON

Guardsmen Fire Army's

THE *HONEST JOHN* is still the mainstay tactical surface-to-surface missile of the U.S. Army.

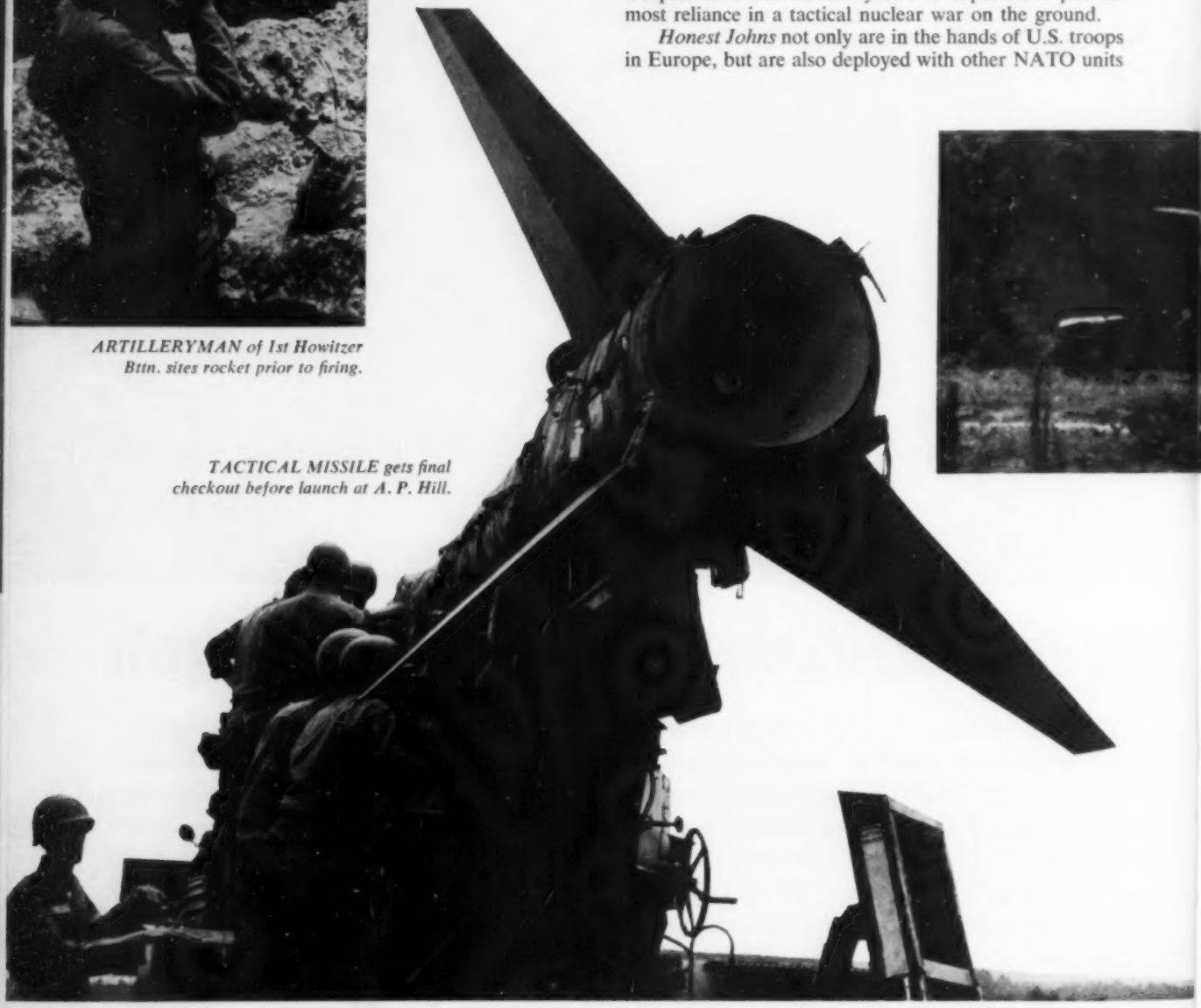
The 12-mile-range missile represents the principal tactical nuclear punch of U.S. troops on the Central Front in Europe.

Except for *Lacrosse*, *Honest John* is the only short-range nuclear missile available in any quantity. It is the weapon on which the Army can be expected to put the most reliance in a tactical nuclear war on the ground.

Honest Johns not only are in the hands of U.S. troops in Europe, but are also deployed with other NATO units

ARTILLERYMAN of 1st Howitzer Bttn. sites rocket prior to firing.

TACTICAL MISSILE gets final checkout before launch at A. P. Hill.



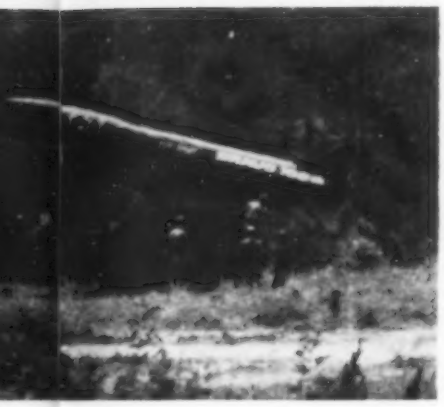
Honest John Battlefield Work Horse

—including the Italians and West Germans.

U.S. troops have had considerable experience in operating with *Honest Johns* in maneuvers both overseas and in the United States since the missile became operational in 1953.

National Guard troops began training with *Honest Johns* this summer. The 28th Infantry Division in July became the first Guard unit to launch an *Honest John*.

The launching—depicted on these pages—was conducted by the 1st Howitzer Battalion of the 28th's 108th Artillery at Camp A.P. Hill, Va.



LEFT: *Missile on transporter-launcher drawn by jeep awaits firing. Equipment not shown includes standard five-ton crane for manhandling missile onto its launcher, wind-set for gauging weather conditions.*

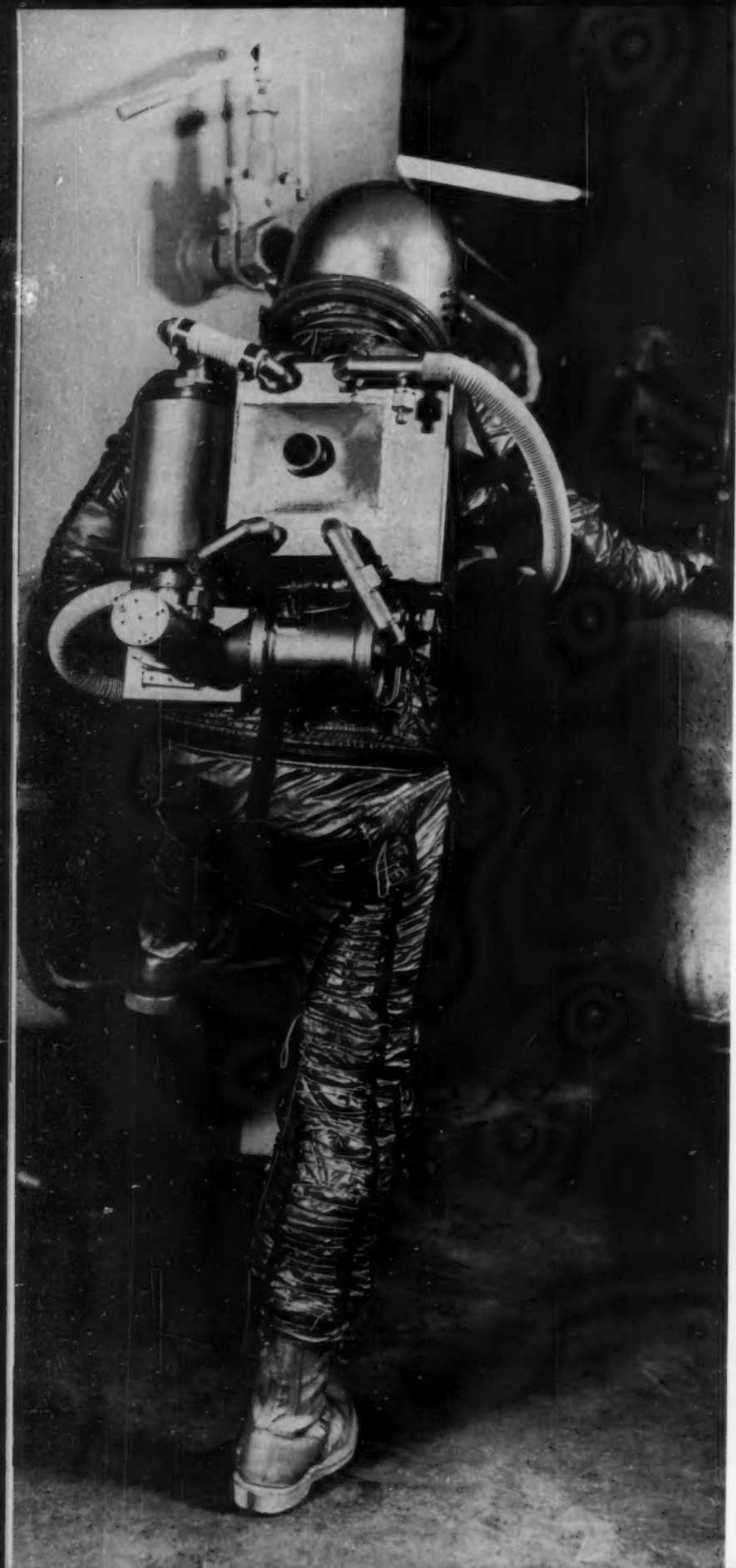
RIGHT: *Last-minute check of wiring is conducted by the Pennsylvania Guardsmen.*

BELOW: *Honest John takes off successfully in first firing by National Guard troops.*

Superoxides

MSA Research says system can be readily produced for Apollo; cites simplicity, lightness, other benefits

by Heather M. David



LEFT: *Space backpack contains superoxide system which completely cools suit, removes odors, trace contaminants, bacteria, CO_2 and water vapor, and supplies oxygen.*

RIGHT: *Mouse has existed breathing only oxygen supplied by an open superoxide bed in his sealed "cabin." Passive system tends to overproduce oxygen; in active system (see flow diagram, p. 32) oxygen production can be regulated.*

FAR RIGHT: *Machine man (console) is undergoing a test at MSAR's sealed chamber. Equipment designed by company can simulate breathing process of one or more men, provide data for days without tying up company personnel.*

Developed to Supply Astronauts' Air

CALLERY, PA..—Just a few pounds of highly active yellow granules may one day furnish all of an astronaut's oxygen.

Two compounds, both superoxides, show great promise as reliable sources of fresh, comfortably dry air free of contamination. A Pennsylvania company has developed their use to such a degree that company spokesmen say they are ready to engineer and produce systems for an *Apollo*-type flight.

The chemicals are the extremely active oxides of potassium and sodium —KO_2 and Na_2O_2. MSA Research Corporation, wholly-owned subsidiary of Mine Safety Appliances, is working under contract to the National Aeronautics and Space Administration and the Navy on their use for space. The NASA award came after more than a decade of company-funded studies.

MSAR lists these advantages of a superoxide system over conventional high-pressure or liquid oxygen systems:

—**"All-in-one" simplicity**—One canister of either potassium or sodium superoxide will accomplish all the things which must be done to purify used air: it removes CO_2 (lithium hydroxide is used in the *Mercury* system, molecular sieves also have been used); it removes some water; it removes trace contaminants including indole and skatole (digestive gases), for which activated charcoal generally is suggested; it removes bacteria, and it produces oxygen.

—**Lightness**—A supply of one of the superoxides accomplishing all these things would amount to about 4 lbs. of chemical per man day. Heavy containers like those used for storing LOX or high-pressure oxygen are not required.

—**Volume**—The amount of space required to store a supply of superoxide is less than that required for lithium hydroxide needed for the same amount of time. Little equipment is needed. The chemical may be stored and used in a thin wall canister. The other major components are a blower and heat exchanger.

—**No high pressure**—The system operates at ambient pressure. There is no risk of failure in high-pressure fittings.

—**Reliability** — Minimum moving parts and lack of complicated valve systems make the system very reliable. The chemical will always react for its given life.

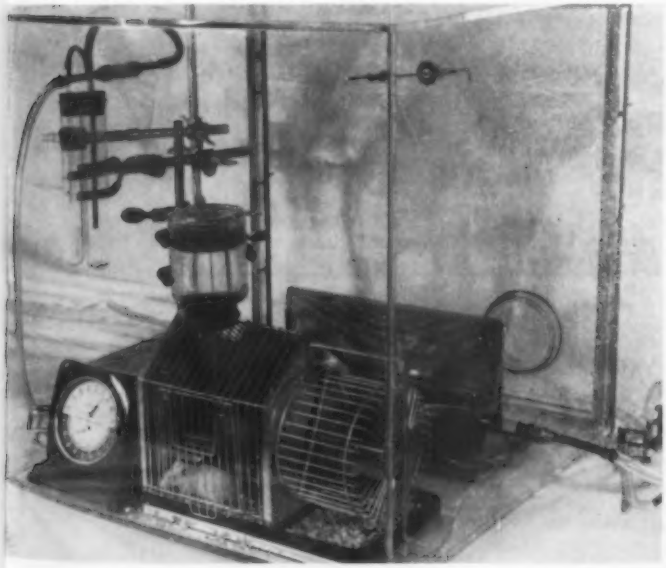
—**Engineering flexibility**—The canisters can be made into any shape and can be designed to fit otherwise useless corners or spaces.

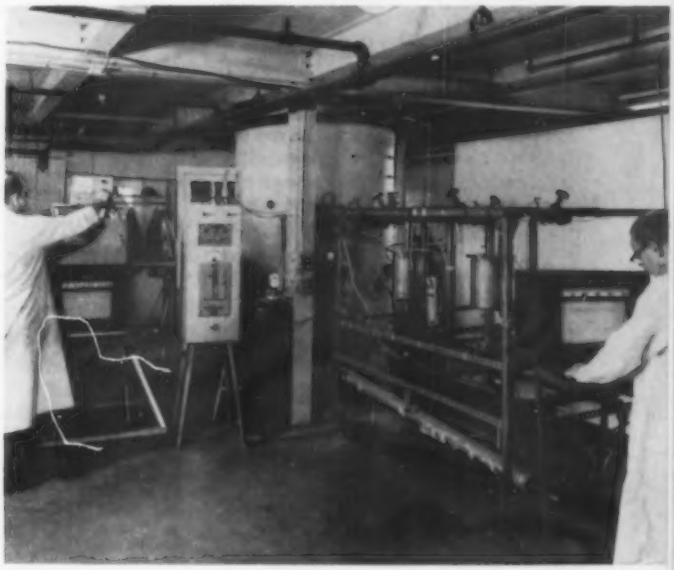
—**Bacteria removal**—The chemicals appear to be very effective in removing many respiratory viruses and bacteria. This obviously has special advantages for a crew of several men.

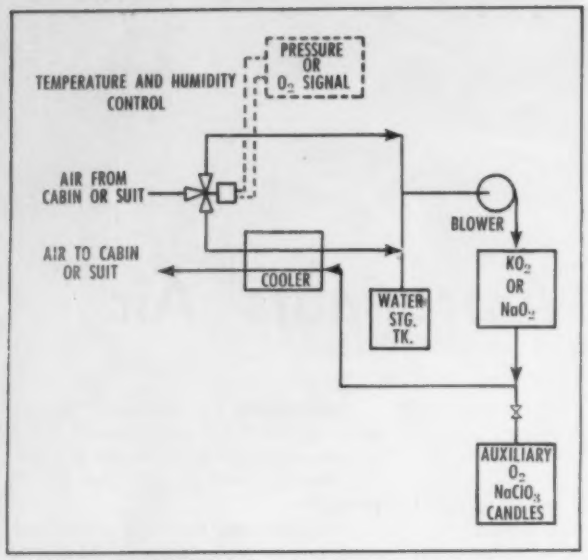
The system got a good test last year at the Navy's Air Crew Equipment Laboratory in Philadelphia. Six men spent a period of eight days in a sealed chamber breathing oxygen supplied by a potassium superoxide system.

In the chamber, a blower circulated air through a cooling apparatus, then through the superoxide canister. Total oxygen released was from 80 to 95%. The canisters removed part of the water vapor, and all odors, trace contaminants.

An ingenious machine at MSAR has run hundreds of tests simulating the







SUPEROXIDE SYSTEM flow diagram—Active system.

oxygen consumption and CO_2 output of one or more men. This machine, placed with a superoxide system in a closed chamber, has provided data on the action of a crew of as many as six men for as long as a week. It proved the success of MSAR's invention.

The company also has maintained mice for months on superoxides, using both dynamic and passive systems. A passive system is one in which the air makes contact with an exposed bed of superoxide and is thus regenerated. If the blower in a dynamic system should break down, or there should be a loss of power, the astronaut could still make use of the canister.

The mouse experiment and some of MSAR's equipment is being shown this week at the American Rocket Society convention in New York City.

• **Oxygen production rate**—The dynamic system has advantages because it can be regulated so that oxygen is not overproduced. Man's average RQ, or respiratory quotient—the ratio of CO_2 emitted to oxygen inhaled—is 0.8. The superoxide can produce anywhere from 0.6 to 1.1 oxygen to CO_2 taken in. This is accomplished by regulating the temperature and amount of water in the air that goes into the canister. MSAR is investigating several mechanical means of cooling for use in space.

The company, largest producer of potassium in the country, has a good background for space cabin work. It pioneered in producing chemical air purifiers for miners, industrial workers, fire fighters and submarines. It also developed a superoxide "backpack" for use with pressure suits, which has been tested at the Air Crew Equipment Laboratory.

A space backpack will weigh about 25 lbs., contain enough chemical for a period of two hours or more, and completely cool the suit as well. Developed under a Navy contract, it has the trade name Chemacon.

The Mines Safety Appliance subsidiary also helped design the lithium hydroxide containers for Project *Mercury*, and is working with molecular sieves. Its scientists have developed an electrolysis cell for the Navy which will decompose CO_2 to carbon and oxygen.

• **Backup oxygen supply**—In addition to the super-oxide granules, MSAR suggests that in a space emergency, oxygen might be supplied by chlorate candles, another company development.

Chlorate candles are manufactured of finely divided iron powder mixed with sodium chlorate. Glass fiber serves as a binder. Barium peroxide is added to inhibit the evolution of chlorine. The sodium chlorate is heated, the other materials added and the molten mass cast into cylindrical "candles." The materials can also be mixed with water, pressed, then dried.

Upon ignition of an iron-enriched spot on the candle, it emits medically pure oxygen until it is consumed. MSAR says that a candle the size of a cigar would provide enough emergency oxygen for a man for 15 minutes. However, auxiliary means of removing CO_2 and water must be employed when the candles are used as a sole source of oxygen supply.

Shelf life of these candles is said to be unlimited. They have been stored indoors for 15 years without any change, even though they had no protective covering.

The candles have been adapted to aircraft emergencies; one particularly useful for bailout produces a large flow of oxygen for a few minutes, then gradually decreases.

Rate of flow and flow pattern is determined by size and configuration.

There is no known upper limit of oxygen pressure which can be generated by the candles. A portable unit developed for the Army Corps of Engineers incorporates a reservoir which sustains a steady flow while the candles are being changed.

• **Safety**—Both these oxygen sources are said to be quite safe for use in space cabins. Potassium superoxide is a strong alkali which should be handled with gloves, but with the use of canisters there should be no reason for touching the chemical. Although the dust may be somewhat irritating if present in quantity, it is less irritating than that of lithium hydroxide.

A KO_2 canister can be destroyed by perforating the can and immersing it in water. The spent chlorate candle is inactive ash. ⌗

Non-regenerative

O_2 Sources—lbs. O_2/lb.

Li_2O_2	0.35
LiO_2	0.61
Na_2O_2	0.20
*NaO_2	0.43
*KO_2	0.34
CaO_1	0.46
H_2O_2	0.47
KO_3	0.46
Candles	0.40
7500 psia O_2	40 lbs./cu. ft.
Liquid O_2	71 lbs./cu. ft.

CO_2 Absorbers—lbs. CO_2/lb.

LiOH	1.09
$Ca(OH)_2$	0.59
NaOH	0.55
KOH	0.39
Li_2O	1.46
Na_2O	0.71
K_2O	0.46

**Potassium hydroxide and sodium hydroxide are not the highest oxygen-producing sources, but the other superoxides have been difficult to work with. Significant feature is that they do both things at once.*

Russians High on Molluscs As Source of Food in Space

FUTURE Soviet manned space capsules may be marked by a decidedly fishy odor.

Recent reports from Russia indicate that physiologists are very interested in the potential of molluscs as a food.

"Molluscs," says V. I. Danyleyko in the *Fiziologichnyy Zhurnal* (Physiology Journal) "scarcely differ from meat." Their bodies contain 78.11% moisture and 21.89% dry substances. This includes 19.1% protein, 0.54% carbohydrates and 0.45% fat. Furthermore, molluscs can be grown on small amounts of algae.

Zooplankton cultivated on algae grown in human waste would supplement the cosmonaut's diet. ⌗

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OPTICAL EQUIPMENT operators may avoid nuclear flash blindness through a device being perfected by Electro-Optical Systems, Inc.

The experimental model is designed to protect personnel using high-powered binoculars and telescopes for reconnaissance or field bombardment spotting. The mechanism can effectively and automatically close out the light from a nuclear flash in one ten-thousandth of a second.

Anti-flash measures are a problem in aircraft and shipboard operations as well as in tactical battlefield situations; studies are under way to extend the principle to these applications.

The protection device consists of a stressed plate shutter placed in front of the objective end of optical instruments. The shutter assembly includes an ordinary piece of glass mounted between a pair of rigid beams. Stacks of piezoelectric drivers are placed at either end of the beams.

MODEL of shutter mounted on binoculars.

Voltage applied to these driver stacks causes expansion or contraction depending on the voltage polarity. Strain induced in the glass causes temporary double refraction, which changes the state of polarization of a light beam passing through the shutter plate.

If the shutter plate is placed between a pair of crossed or parallel polarizers and a modulation voltage is applied to the driver stacks, the light beam passing through will be modulated from a full-open to a full-close. The shutter is a mechanical analog of the kerr cell.

In addition to the rapid closure time, the eye protection device will be capable of opening as quickly as possible after the initial flash. This is to make possible visual inspection of a battlefield immediately after a nuclear explosion.

The unit can be adapted to field use with battery power. The development is being sponsored by the Frankfort Arsenal, Army Ordnance Corps. ⌗

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Army R&D Dollars Now Go to Industry

Von Braun-less ABMA shifts emphasis to outside development, but still sees bright future

by James Trainor

HUNTSVILLE, ALA.—A major shift in emphasis from in-house development of missile systems to reliance on outside contractors is the most significant result of the transfer of the "Von Braun team" from the Army Ballistic Missile Agency to NASA.

Some 90% of the money appropriated for the Army Ordnance Missile Command now is going to industry, according to Maj. Gen. August Schonberg, AOMC commander.

More than 54,000 businesses are sharing in the contracts.

The transfer of more than 4000 people and $100 million of facilities and equipment, Army officials point out, forced ABMA to re-examine both the relationship of the agency to the contractor and the function of its research and development division. This rethinking has brought about changes in organization, contractor philosophy and in-house capability.

• **What goes on now** — When the transfer was effected on July 1, 1960, ABMA was left with only three programs—*Jupiter, Redstone* and *Pershing* —and only one of these, *Pershing*, could really be said to be under development. However, since the agency was to develop "systems whose trajectories are predetermined, essentially ballistic in nature," seven systems with their project personnel were transferred from the Army Rocket and Guided Missile Agency to ABMA on August 1, 1960. These seven were: *Corporal, Sergeant, Honest John, Little John, LAW (Light Anti-Tank Weapon), Missile A* and *Missile B*.

However, of the 10 now under ABMA's wing all but *Pershing, Missile A* and *Missile B* are in production or actually in the field. This means that the industrial and field service divisions of the agency are coming more to the fore. It is the responsibility of these divisions to provide the industrial, logistic and maintenance support for the systems in the field. Until the *Sergeant* becomes operational, none of the systems developed over the past years has been obsoleted—which means that the workload on these two divisions is constantly increasing.

• **Organizational changes**—To place greater emphasis on future Army requirements for missile systems and to provide sound management for systems under development, Brig. Gen. Richard M. Hurst, ABMA Commander (see box), has made two important organizational changes.

First, he has established an Advance Plans Division responsible for evalu-

Scholarly Commander Steers Agency Through

BRIG. GEN. Richard M. Hurst, commander of the Army Ballistic Missile Agency, represents a sharp break with the flamboyant past of the Medaris era. Quiet, unassuming Gen. Hurst, according to his associates, is a highly competent soldier-scholar who is interested in sound management and value engineering.

Coming to ABMA shortly before the transfer of the highly touted Von Braun team to NASA, he has overseen the dismantling of one agency and the rebuilding of the "new" ABMA. However, as he pointed out in an interview with MISSILES AND ROCKETS, the job of building up the organization is still unfinished even now—fifteen months after the transfer.

• **Background and experience**—Although relatively unversed in the missile field prior to his assignment as commander of ABMA, Gen. Hurst, '52, has a long list of achievements both as an ordnance officer and as a student. Educated in the elementary and secondary schools of Indiana and South Dakota, he graduated from Purdue in 1930 with a degree in Electrical Engineering. Later, at

ating contractor proposals, keeping abreast of the state-of-the-art and recommending systems for development that would be beneficial to the Field Army or its elements in 1965-70.

Second, to improve management techniques and to take advantage of new techniques Hurst has established a Policy Planning Council which reports directly to him. This body—consisting of four highly qualified officers—studies the organization's present structure and recommends changes or the incorporation of new techniques that have proven successful in other programs. For example, PERT—highly successful in the *Polaris* program—is one of the many approaches to program management that have been studied by this group.

• **Contractor philosophy changes**—Under the Von Braun approach, contractors often found themselves with nothing to do in the development of an Army missile system. They were presented with an already designed and fabricated system and told to produce it—with some product improvement allowed. However advantageous this method may be, ABMA can no longer use it to build ballistic weapons for the simple reason that the agency does not possess the tremendous in-house capability in men and materials that such a system entails.

This does not mean, however, that ABMA intends to abrogate its responsibility for system development. One of the major tasks of Research and Development Operations—headed by Dr. Arthur Rudolph—will be to oversee the contractors' efforts and to provide technical guidance and supervision to industry.

SERGEANT—here blasting off at White Sands—is one of 10 systems under ABMA.

• **In-house capability changes**—These changes in emphasis are clearly evident in the organization and functions of Dr. Rudolph's department. Broken down into six labs (compared to ten in the old organization), the group is expected to have a maximum strength of little over 1000 engineers, scientists and administrative personnel. This compares to approximately 4500 before the transfer.

This cutback in personnel is attributed to the change in the contractor approach. It also enabled the Army to combine some of its labs in order to get maximum utilization of its resources.

The labs, in conjunction with project offices in the headquarters element of the R&D Operations, will provide the technical know-how to monitor Army contracts. In addition, they will be called upon to project and apply the state of the art to advanced missile systems. The major burden for this advance planning, however, rests with one lab: Analysis and Advanced Design. It will develop the technical characteristics for new systems and work with a system until it becomes a funded project. At this point, A&AD Lab's interest in the program is transferred to a project office.

Research Lab—under Dr. Gerhard Reisig—is charged with providing the supporting research necessary to insure the uninterrupted development of a system. In the past, there have been instances in which programs have been delayed because, as one R&D man put it, "we didn't do our homework." It is Dr. Reisig's job to see that this doesn't happen in the future.

• **What of the future?**—The fielding of these 10 systems, however, does not mean the end of ABMA's R&D tasks. Under study are programs to develop a longer-range, more accurate *Pershing* for use by the field Army. At the other end of the spectrum, increased attention and emphasis are being placed on small rockets and missiles to provide both heavy and light antitank and assault weapons for battlefield use, and on meteorological rockets for use with tactical systems to provide up-to-date meteorological and climatological data to the firing unit. The development of Multi-System Test Equipment is also being examined in a joint effort with ARGMA.

Other areas of interest include: extremely low-cost frangible boosters which would provide safety to troops in

Sharp Revisions in Staff and Assignments . . .

Northwestern, he received two post-graduate degrees: Master of Business Administration and Doctor of Philosophy.

Upon graduation from Purdue, he received a reserve commission in the Field Artillery. However, it was not until 1935 that he was called to active duty for three years. He returned to active duty in 1940 in the Ordnance Corps, and was integrated into the Regular Army in 1946.

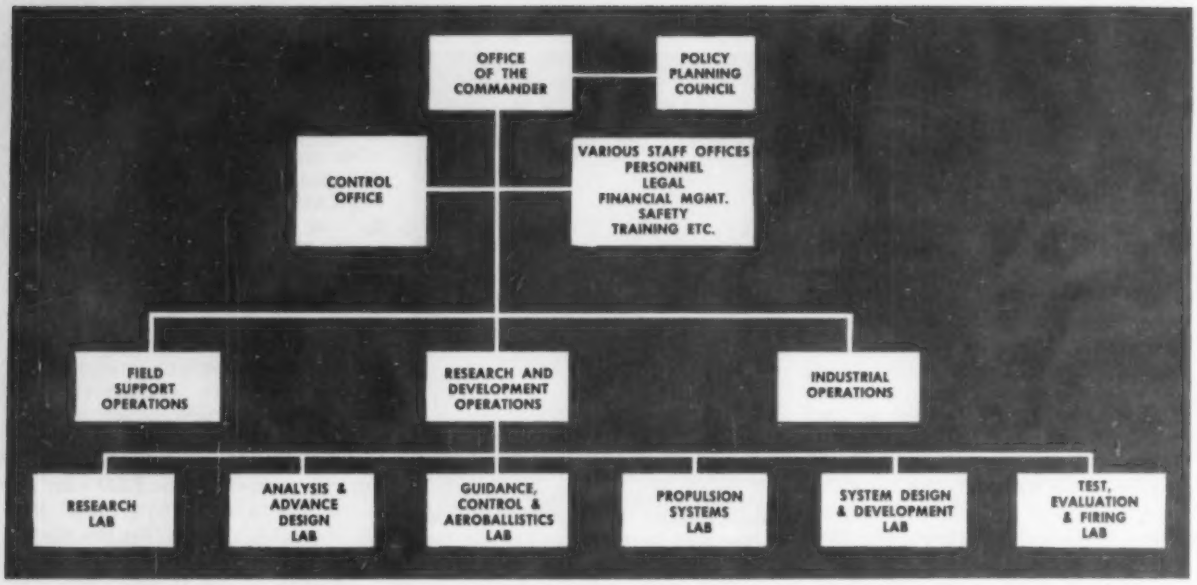
During World War II he served in Ordnance positions at Fort Benjamin Harrison, Ind.; Fort Hayes, Ohio; and the Central Pacific area. After the war he was assigned to Mt. Rainier Ordnance Depot and the Office of Chief of Ordnance in Washington. After completing the course at the Armed Forces Staff College, he served successively as Deputy Ordnance Officer for the Eighth Army in Korea, Asst. Commander, Ordnance Weapons Command, Commander of Watertown Arsenal, and Deputy Commander of the Ordnance Tank-Automotive Command.

• **Vocation and avocation**—One of those fortunate individuals who has been able to combine work with pleasure, Gen. Hurst admits that although he hasn't been able to play much tennis lately, his job gives him a chance to practice his main hobby: the study of management and the effective application of its principles. This predilection is clearly evident in the changes and re-orientation of the agency since General Hurst assumed command. Particularly, the emphasis on advance planning to insure ABMA's future and on value analysis is aimed at getting maximum possible mileage from the dollars filtered down to the agency.

Gen. Hurst is married and has two children: Nicholas, a cadet at the U.S. Military Academy, and Susan, a high school freshman.

Promoted to General in July, 1960, Gen. Hurst has won the respect of his subordinates by the manner in which he has kept the agency on course in spite of the NASA transfer and the addition of six new development programs. As one of them put it, it was like "coming out of the dugout without any warmup and finding yourself at bat with two strikes on you."

Neither the agency nor its Commander has struck out yet, he added. ■



Organizational Chart of Army Ballistic Missile Agency

front of the launch area; improved mobility with consideration being given to Goer and zero-ground-pressure vehicles; and the development of special armaments for conventional and unconventional warfare.

• **Inadequate facilities**—Perhaps the most discouraging aspect of the transfer is the inadequacy of the facilities that ABMA has occupied for the past year. Scattered over the length and breadth of Redstone Arsenal, the agency occupies some 36 buildings—ranging from an old munitions packing line to quonset huts and warehouses.

ABMA also shares its headquarters building with the Marshall Space Flight Center, which has not only the third floor of the building but also the complete fourth wing.

This impractical situation will be alleviated, however, by two upcoming construction projects. The first is a new, eight-story office building for the Marshall Center—scheduled to get under way this year. This will take some of the strain off of ABMA by returning to them the office space now occupied by NASA in the headquarters building.

The second construction project—just approved by Congress—provides for a $4.75-million research and development facility. This building will eventually house elements of all the labs.

A static test stand has recently been completed and turned over to ABMA's Test, Evaluation and Firing Lab. Although the instrumentation is not completely finished, the first captive tests were run on the stand last month.

• **Continuing problems** — With the construction of new facilities many of ABMA's problems will be solved. However, there are two nagging difficulties which have the agency worried. The first is the continued buildup of NASA and particularly the Marshall Center. Since the human resources in the Huntsville area are limited, and the past year has been to a degree frustrating due to the lack of facilities, ABMA officials are worried they will lose more of their best people to NASA.

According to one official, everyone of any value in the Army organization has at least one job offer from Marshall. He is worried that many of these people may be lost to the Army.

"They offer our people new ways to do new things," he explains, "while we offer them new ways to old things." Admittedly, NASA has a greater appeal for this reason.

The second problem is to get greater recognition of the importance of supporting research at higher levels of command and a greater creativity at lower echelons. Most people endorse supporting research, the argument runs, until it is time to spend money on it—then they are only interested in hardware. Since the store of basic knowledge is diminishing, it is more important than ever that adequate supporting research funds be allocated not only to ABMA but to other development agencies as well.

To effectively utilize these funds and to develop the ideas for future systems, ABMA is trying to find or develop creative engineers. As one official expressed it, if ABMA could get six really creative people, it could build up a brain trust which eventually would become so strong and respected that the people who determine Army requirements would buy the agency's recommendations more readily.

Fifteen months after the NASA transfer, ABMA is not so much reorganized as reoriented. The agency is still recovering from the loss of last year. However, with its attention directed exclusively to providing ballistic weapons to the Army, its chief spokesmen describe its future as bright. ¤

System Fills Agena Tanks With Near-Perfect Accuracy

A SPECIALIZED propellant transfer system for the *Agena* series of satellites is being installed at both Cape Canaveral and Vandenberg AFB, Calif.

The 19-ft.-long units, developed by Lockheed Missiles and Space Company's Van Nuys, Calif., plant, are said to be capable of filling *Agena's* fuel storage tanks with an accuracy of 99.9% or better.

Two of the transfer systems are used with each vehicle to be fueled. Each system contains a 1300-gallon tank. One propellant weight tank contains inhibited red fuming nitric acid (IRFNA) and the other unsymmetrical dimethyl hydrazine (UDMH). Propellant is transferred in a "just right" amount, slightly over 1200 gallons, flowing into the *Agena* at approximately 40°F at a rate of 40 gallons per minute.

Each system is equipped with semi-automatic electrical and pneumatic systems for propellant transfer, plus safety features to minimize explosion and fire dangers. The valves, pneumatic and electrical controls on the unit can be operated by one person, but during actual countdown procedures, all controls are handled remotely from the launch blockhouse. ¤

cover story

Huge 'Beetle' to Handle Nuclear Power

"BEETLE" with cab in lowered position, shown in photo of GE model.

A MAMMOTH 80-ton tracked vehicle, shielded for handling nuclear power and propulsion equipment, is under construction at General Electric's Cincinnati plant for the Air Force Systems Command.

Powered by a 525-hp gasoline engine, the vehicle — nicknamed the "Beetle"—will enable its operator to operate in close proximity to highly radioactive equipment. It is shielded against radiation by foot-thick lead sheet. Its leaded glass windows are nearly two feet thick. This shielding will enable its use during tests of nuclear rockets to make adjustments without stopping the tests.

The vehicle is equipped with two huge mechanical arms, a periscope, TV cameras, radiation measuring instruments and high-intensity lights.

The operator's cab can move up and down or rotate. It is equipped with two-way radio, a TV screen and air conditioning. Height of the cab is 25 ft. when raised, 10 ft. when lowered.

The "Beetle," measuring 19 ft. in length and 12½ ft. in width, has a top speed of 10 m.p.h. The robot mechanical arms, with a maximum reach of 18 ft., are sensitive enough to pick up an egg without breaking it and strong enough to bend a steel bar.

After completion of construction at Cincinnati this winter, the AF Special Weapons Center will test the monster in cooperation with the Atomic Energy Commission at the Nevada Test Site. Its capability to move over various types of terrain and to manipulate different nuclear power and propulsion systems will be checked out in a program expected to last about six months.

Subsequently, the Air Force expects to use the information for design of second-generation air-transportable handling vehicles for its nuclear power programs.

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Three-year gap?. . .

Reds May Be Using Saturn-Class Boosters

Examination of known data and logical estimates of progress suggest thrust of about 1.5 million pounds

by Dandridge M. Cole

Consulting Astronautical Engineer
Missile and Space Vehicle Dept.,
General Electric Co.

THE CURRENT SERIES of Russian missile firings in the Pacific area indicates the Soviet Union may already have boosters in operation equivalent to the U.S. *Saturn*, which is scheduled for its initial test launching next week (see p. 9).

If true, this means the Soviets are as much as three years ahead of the U.S. in efforts to send a man to the moon.

The Soviet launchings of a new rocket of even greater size than the *Vostok* launcher raise anew the issue of the space booster gap and the attendant questions regarding the performance of Russian space launchers.

The question of orbital payload capability is reasonably clear, assuming that Russian announcements on payload masses have been accurate. These statements have been generally accepted as correct by U.S. experts and have been confirmed indirectly by photographs of rocket stages in orbit, the performance of the *Vostok* capsules and other evidence.

• **Thrust overestimated?**—The picture on rocket thrust, size, and configuration, however, is not so clear. While not as important as payload capability, the question of thrust, in particular, has been of continual interest and may be of some importance in assessing growth potential and future payload capability.

Although Russia has never disclosed the thrust of the *Vostok* launcher, it has frequently been stated as fact by U.S. publications that the thrust is 800,000 lbs. In spite of the wide use of this figure, however, there are several good reasons for questioning its accuracy.

Rocket experts in the West have maintained almost without exception, since the launching of the first *Sputnik* in 1957, that Russian rockets were larger, simpler, cruder, less efficient, but more reliable than their American counterparts. This view was neatly expressed by Herman Oberth in his famous statement that "the Russians were building alarm clocks while the Americans were building ladies wrist watches."

This view has not been seriously challenged. In fact, it still seems to be a highly reasonable belief consistent with all the known *facts*. It is not, however, consistent with the *belief* that the *Vostok* launcher had a thrust of 800,000 pounds and a takeoff mass of about 500,000 pounds!

• **Realistic gauge**—A useful measure of overall rocket mass efficiency is the gross-to-payload ratio—takeoff mass divided by payload mass. U.S. performance as measured by this parameter has increased rapidly since 1958.

The first *Explorer* in 1958 had a payload ratio of about 3000 and the first *Vanguard* about 7000. In *Vanguard III*, this was improved to 450. With *Midas II*, U.S. performance improved to 70 and with future vehicles even better performance is expected. *Saturn C-1* should reach about 50 and the *C-2* was to have reached 25 (with high-energy upper stages).

The Russian rocket which carried 14,000 lbs. into orbit early this year would have a payload ratio of 37 at a gross mass of 500,000 pounds. This would be almost twice the mass efficiency of the best U.S. effort to date and better than any lox-kerosene rocket being developed in this country.

If these figures are true, then Russia must either be credited with a lead in propulsion techniques (high-energy chemicals) or a lead in structural design, or both, in addition to their acknowledged lead in size. Belief in this kind of Russian advantage is a little too much like the belief that they are 12 feet tall and does not seem reasonable. It would appear to be more likely that they have gained their booster lead by the simple and direct approach of building larger vehicles.

It can be assumed that the *Vostoks* and the *Venus* probes used the same booster stages, but that the *Venus* probe used a three-stage configuration and the *Vostoks* two stages. This would be consistent with a desire for higher reliability in the manned vehicles and with the difference in payload.

• **Saturn already here?**—Also assuming that the payload ratio for the *Venus* probe was 70 or the same as the U.S. best to date, then the big Russian space booster has a gross mass of approximately one million pounds and a thrust of perhaps 1.5 million pounds. In other words, Russia already has something equivalent to *Saturn* in operation.

This estimate is supported by the official Russian statement that the *Vostok* launcher had a takeoff horsepower of 20,000,000. If it is assumed that the propellants are kerosene and oxygen with an exhaust velocity of 8000 feet per second, then the takeoff thrust would be $20 \times 550 \times 10^6$ divided by 8×10^3, which is equal to 1.38×10^6.

This figure is further supported by the official Russian statement that the *Vostok* launcher had six engines. Presumably these would be the largest available proven and reliable engines. It has been known for more than six years that a group of captured German scientists designed a 220,000-lb.-thrust engine, the R-14, for a Russian IRBM. Now, if six R-14 engines were clustered for the *Vostok* launcher, the total thrust would be 1.32×10^6 lbs.

• **Step by step**—It is interesting to speculate as to the probable course of Russian rocket development in the past and its possible future direction. Some

estimates of the growth in thrust and gross mass are illustrated in Figure 1.

Russia captured *V-2* production facilities in 1945 and began to produce these rockets in quantity with little loss in time. By 1950, with the help of captured German scientists, they had developed an improved short-range rocket with about 100,000 lbs. of thrust, and it is generally agreed that by 1955 they had an IRBM with 220,000 lbs. of thrust and weighing perhaps 150,000 lbs.

In May, 1958, Russia launched *Sputnik III* with a payload of 3000 lbs. If we assume a payload ratio of 100, the booster must have had a takeoff mass of about 300,000 lbs. If two R-14 engines were used, the thrust would have been 440,000 lbs. It may be that one of their short-range rockets was used as a second stage.

Now how did they make their next big step to the *Vostok* launcher? It was assumed earlier that the six engines used were R-14 engines. Thus, they could have constructed the first stage by clustering three of the *Sputnik III* booster stages—resulting in a booster of almost one-million-pounds takeoff mass.

The Russian rocket program has been impressive in at least two important respects, other than the rocket size. One is an apparent high degree of reliability. The other is the short development cycle of their new vehicles. Both of these characteristics could be accounted for by assuming the development of standardized and routine procedures for clustering proven hardware with a minimum of modification during the clustering process. Some loss of performance would be accepted as preferable to modification, with its resulting loss of time and reliability.

• **Side by side**—Because of its consistency with this philosophy of clustering standardized tank-engine modules, the lateral staging method, suggested by the writer in 1951, might have been adopted by the Russians.

In lateral staging as opposed to tandem, stages are clustered side-by-side. All engines are ignited on the ground. When first-stage propellant tanks are empty, the first stage drops off while the second stage *continues* under power rather than starting at the time of staging as in the tandem method. By using all engines at takeoff, the maximum weight can be lifted from the earth for a given number of engines.

The propellant mass fraction of the lateral-staged rocket can be improved by using propellant from only the first stage tanks during first-stage burning and then switching to the second-stage tank for the sustainer phase. Thus, the main difference between the tandem and the lateral methods is that the second stage or sustainer engine has been borrowed during the boost phase to raise the booster thrust.

The advantage in propellant fraction gained in using lateral staging might be converted into propellant tanks sufficiently strong to use pressure feed rather than pumps. This would decrease cost and development time and increase reliability.

Lateral staging might be the explanation for the large size of *Sputnik III* final stage which was photographed in orbit. This orbiting stage was estimated to be about 90 ft. long and 8 to 10 ft. in diameter. This is a little difficult to reconcile with tandem staging and more compatible with the lateral method.

• **Advancing by jumps**—And what comes after the *Vostok* launcher? Actually it is already here. Russia has stated that the rockets now being fired into the Pacific are larger and more powerful than the *Vostok* launcher. Since it is their custom to make substantial jumps rather than marginal improvements in booster capability, it seems probable that the new rocket will be larger by at least a factor of two.

This new booster might be constructed by extending the clustering method to twelve R-14's for a total thrust of approximately 3 million lbs. or by using new larger engines. Since the R-14 thrust could presumably be uprated to 300,000 lbs., the new booster could have a growth potential to about 3.6 million lbs.

(Continued on page 49)

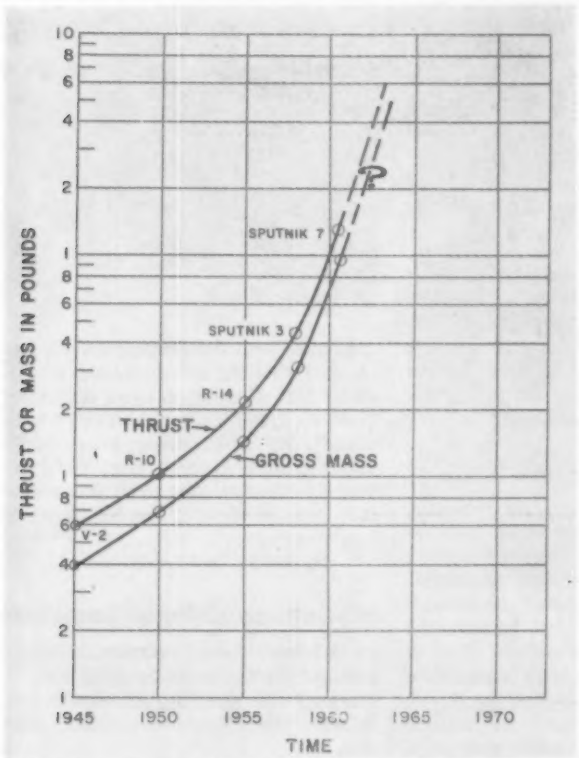


FIGURE 1—Growth of thrust and mass of Soviet boosters.

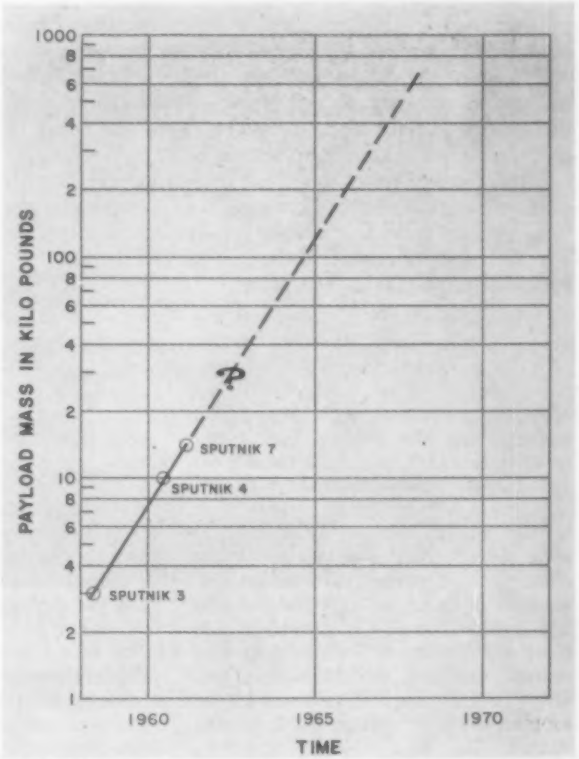
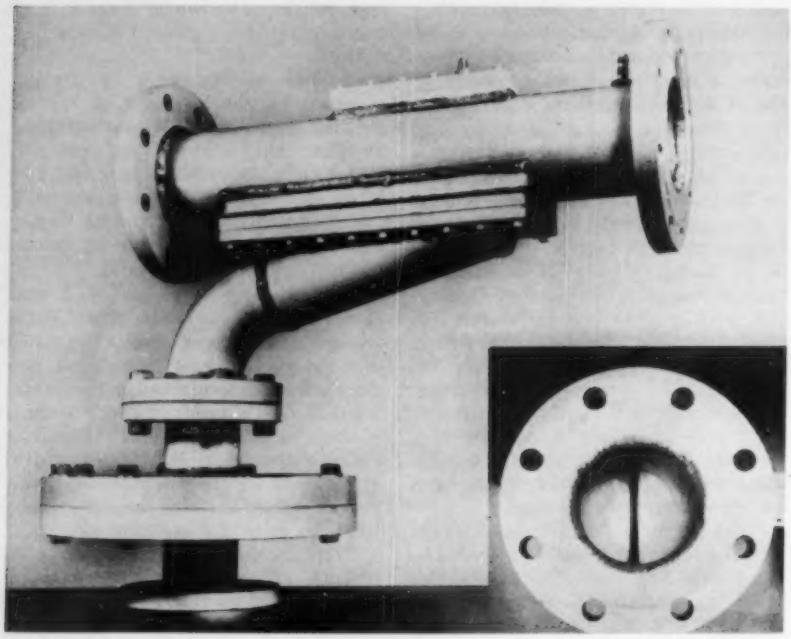


FIGURE 2—Maximum payload capability of Russian boosters.



New Product of the Week:

Flow Sampling Wedge

Wyle Laboratories has designed and developed a high-accuracy dynamic flow sampling wedge for use in ground support propellant loading systems.

Accuracies to within 2.5% in the prediction of main-stream contaminant levels, over extreme density variation ranges, are provided by the wedge.

The sampler is designed so that its unique high-accuracy performance extends to sampling of high-pressure flows. The flow-sampling wedge can be used with any liquid, gas, or combination, and under virtually any conditions of flow, temperature, and pressure.

The possibility of errors due to settling is eliminated by the collection of a "slice" specimen of fluid covering the full vertical cross-section of the stream.

Circle No. 225 on Subscriber Service Card

Hi Voltage D-C Sources

Three precision d-c sources are available from Smith-Florence, Inc.

Offering accuracies of 0.25% of any output voltage dialed, the Model 120 provides 20 ma over the range of 500 to 2210 vdc, the Model 122, 20 ma from 0 to 3000 vdc, and the Model 123, 20 ma from 0 to 6000 vdc.

Only 3½-in. high, the Model 120 features in-line controls, regulated filament power, polarity reversal, modular construction, and removable rubber feet for rack or bench use. Models 122 and 123, mounted on 5¼-in. panels, feature handi-vider in-line controls, voltage and current metering, and reversible polarity. They are the only precision power supplies available that go down to zero voltage.

Other key specifications for the three models: stability, 0.005% per hour; regulation vs. line change, 0.01% for ± 0.10% line; regulation vs. load, 0.01% for 20 ma change; and ripple of less than 5 mv rms at any output voltage and current in either polarity.

Circle No. 226 on Subscriber Service Card

Balance/Calibration Unit

The Model BC411 isolated balance and calibration unit for strain gage instrumentation systems is being marketed by Computer Engineering Associates.

It has a plug-in printed circuit card that makes it possible to change the entire set of calibrations and dummy bridge resistors in less than 30 seconds. It can be used with 6-wire or 8-wire transducer cables, single- or double-shunt calibration, with calibration steps of both polarities. Each unit has a double-level isolation in that both chassis and circuitry are fully isolated from the rack module and adjacent channels, enabling use of the unit with isolated power supplies and amplifiers without compromising overall system performance.

Circle No. 227 on Subscriber Service Card

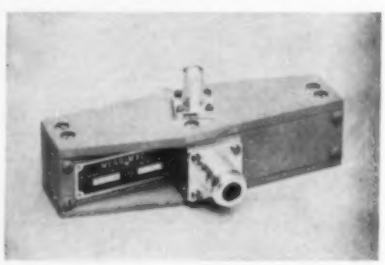
High Power Diplexer

Rantec Corp. is marketing the FUU-401 Diplexer. This unit has been used to provide extremely high isolation between a high power transmitter and a receiver operating on the same antenna system. The unit was designed specifically for the 800-1000 mc band being used for satellite and deep space probes. 120db isolation between the transmitter and receiver is obtained with a receiver pass band loss of only 0.3db. The transmitter arm of the diplexer has an insertion loss of less than 0.1db. The pass band widths are approximately 20mc.

Circle No. 228 on Subscriber Service Card

Variable Attenuator

Merrimac Research and Development, Inc. is marketing an electronically controlled, solid-state variable attenuator, Model AAE-1. The unit is sweepable over a minimum of 15 db of attenuation range over the 200 to 600



mc band, with flat attenuation vs. frequency characteristics. Initial loss is under 2 db at the band edges and under 1 db at band center, and VSWR is under 1.7:1 at band edges and under 1.4:1 at band center. Small (3.25 in. long from input to output), the attenuator requires only a few milliwatts of bias power.

Circle No. 229 on Subscriber Service Card

Miniaturized Potentiometers

A miniaturized, precision multi-turn potentiometer, measuring only ⅜-in. in diameter and weighing just five grams, is now available from General Controls Co.

Designated the PM305, the tiny, 10-

turn potentiometer features a molded body, which contributes to its reliability in temperatures ranging up to 150°C. Rotation of the wire-wound pot is 360°, plus 20°, minus 0°, with an active coil length of 8-in. Torque is 0.5 oz./in. maximum.

Some of the electrical specifications: resistance range, 50 to 100,000 ohms; resistance tolerance ± 0.3%, with the best practical being ± 0.1%; power rating one watt at 85°C (derated to 0 at 150°C).

Circle No. 230 on Subscriber Service Card

Air-powered Transfer Pump

An air-powered transfer pump is now being offered by the Aro Equipment Corp. Called "Little Squirt," the pump is designed to eliminate time-consuming, inefficient hand pumping of fluids from drums to other containers or points of use.

The unit will pump up to 7 gal./min. free flow, and handles fluids up to 90 weight gear oil. The "Little Squirt" will transfer almost any kind of non-corrosive fluids, including oils, gear oils, water, kerosene, gasoline, anti-freeze, thinners and solvents. Delivery is instantly adjustable from zero to full flow, and operation is without hazard from explosion or sparks, because the pump is completely air powered, requiring as little as 15 psi, or on standard line pressures up to 150 psi.

Weighing only 2¼ lb. and measuring 16¾ in. x 11½ in., the pump is said to be the lightest, smallest reciprocating pump on the market, with a record of six million cycles in life test.

Circle No. 231 on Subscriber Service Card

Voltage converters

A low-cost, compact line of precision d-c voltage-to-frequency converters is available from Pioneer Magnetics Inc. The Falcon-Magaverter line of voltage-to-frequency converters is completely solid-state, offering extreme reliability with minimum space and weight. The unit converts 0 to 5 volts (or more) d-c into a pulse or square wave output. This output frequency varies linearly with the d-c input signal from approximately zero cps to the pre-set full-scale frequency. Four standard models give full-scale out-put frequencies of 500 cps to 4000 cps.

Circle No. 232 on Subscriber Service Card

Leakproof Hermetic Pumps

Buffalo Pumps has developed a line of centrifugal pumps, totally enclosed and hermetically sealed for use with toxic, inflammable or highly volatile liquids.

Simplified design includes a long-

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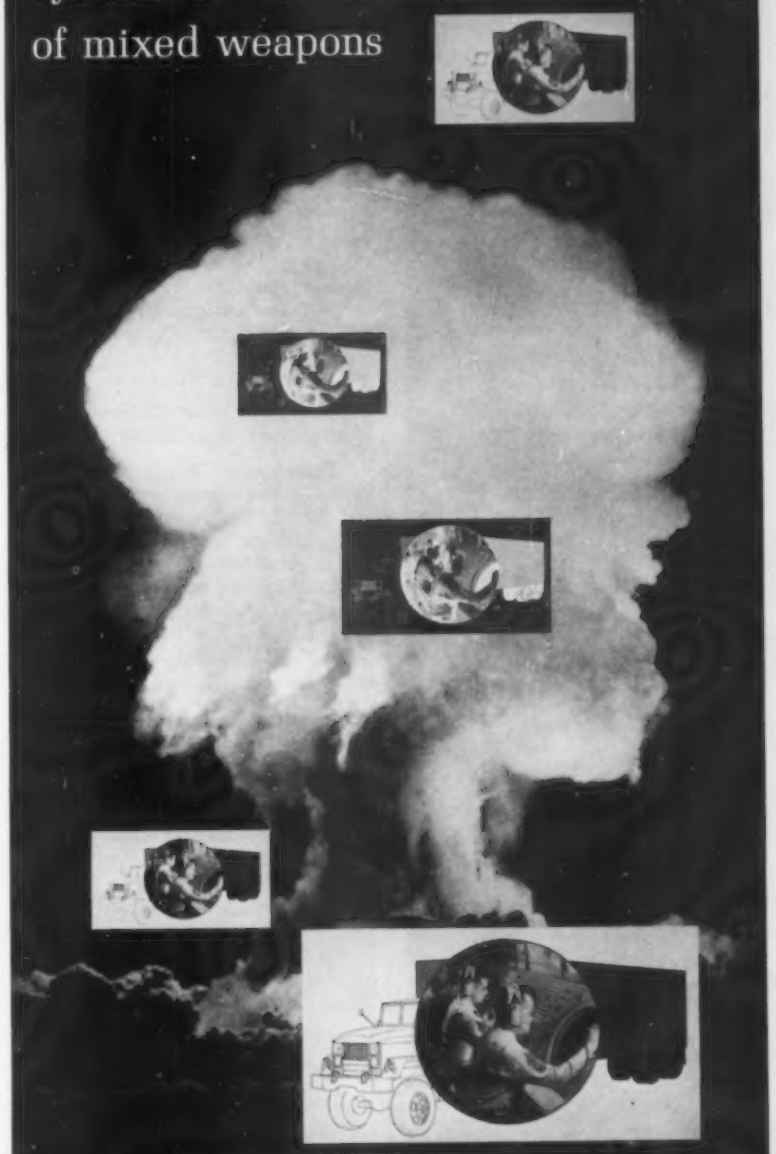

*MOdular DIspersed CONtrol. For descriptive literature on existing hardware, write:

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life, self-adjusting bearing. Mechanical seals and stuffing boxes are eliminated. Positive protection is provided against leakage of expensive or noxious liquids. The line at present includes 13 sizes,

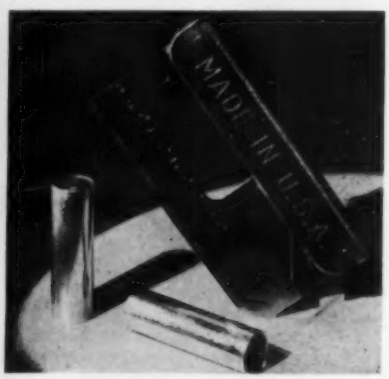
with discharges ranging from 1-in. to 5-in. Standard units are designed for 120 psig and temperatures of 40°F through 250°F. In the event of excess loads, automatic thermo-protectors imbedded in stator rotor windings prevents motor burn-out.

Circle No. 233 on Subscriber Service Card

Microetch Varactor Diodes

The Special Products Operations, Lansdale Div., have developed Philco's line of microetch germanium varactor diodes designed as highly efficient harmonic generators. These units provide simultaneous operation at maximum frequency and maximum voltage.

The series, comprising types L-4110, L-4111, and L-4112, have very high cutoff frequency and greatly increased



capacitance variation, promoting unusual efficiency. The performance of these varactors as harmonic generator devices was continually monitored in Philco harmonic generator circuits.

Circle No. 234 on Subscriber Service Card

Transfer System

The electric Products Division of Vickers, Inc. has designed and developed an all static automatic transfer unit. This device, since it is all static, offers greater reliability together with fast response, low noise level and long life. The present unit is capable of transferring from one 60 cps bus to another in a few milliseconds. This basic unit will be extended to perform the function of bus transfer switches per MIL-S-17773-A except that switching will be accomplished statically and speed of transfer will be improved by an order of magnitude.

Circle No. 235 on Subscriber Service Card

Angle Checker

By combining a plane mirror and a miniature Ultradex indexing table, AA Gage Co. has developed the 360-sided optic-mechanical polygon for checking or calibrating angles. This instrument is guaranteed accurate to ¼ sec./arc, total accumulated error, traceable to the

National Bureau of Standards.

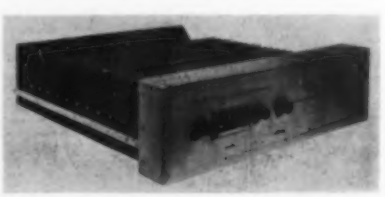
The base is made up of two plates, each with 360 serrations, that are separated when the operating handle is depressed. The top plate can then be moved through any angle and lowered onto the bottom plate. Regardless of what degree of angle is being checked, all 360 serrations engage. This principle allows the serrations to seat uniformly so that the instrument maintains its accuracy through use.

Circle No. 236 on Subscriber Service Card

Low-Level Multiplexer

Individual gain and zero adjustments for each channel are features of a low-level multiplexer recently announced by Systems Engineering Laboratories, Inc. The Model LL-1 Multiplexer accepts differential inputs directly from transducers at levels as low as ±5 millivolts full scale and produces a commutated full-scale output of ±4 volts.

The unit has an input impedance greater than 100,000 ohms and a com-



Circle No. 12 on Subscriber Service Card

mon-mode rejection better than 10^6 to 1 at 60 cycles with 120-ohm unbalanced input. The multiplexer is supplied with up to 48-channel capability, with sampling programs selectable from one front panel rotary switch.

Circle No. 237 on Subscriber Service Card

Adjustable T.C. Resistor

A hermetically-sealed Temp-A-Just resistor with adjustable temperature coefficient is offered by Conrad-Carson Electronics, Inc. Model 7610 has a worm gear lead screw adjustment of T.C. over a range of ±10 PPM/°C to 4500 PPM/°C. Standard fixed resistance values are 100 ohms, 200 ohms, 500 ohms, 750 ohms, 1k, 1.5k, 2k, 2.5k, 3k, 3.5k, 4k 4.5k 5k. Special resistance values and other T.C. spectrums will be made to order. The Temp-A-Just provides adjustable compensations for temperature-sensitive components or circuits.

Circle No. 238 on Subscriber Service Card

Small Fission Counter

An extremely small fission counter with a flexible coaxial cable, Type WX-4706, is now available from Westinghouse Electric Corp. It is designed for thermal neutron fluxes up to 10^8 neutrons/cm^2-sec., or 10^8 nv.

Measuring less than ¼-in. in diameter and less than 3-in. long, the device has an integrally attached 6-ft. length of ⅛-in.-diameter coaxial cable. All metal parts of the WX-4706 are titanium to assure low activation. The insulation is high-purity, vacuum-sealed ceramic.

Thermal neutron sensitivity is 10^{-3} cps/nv, with a minimum resistance of 10^{12} ohms. Normal operating voltage is about 300 volts, but up to 1000 volts may be applied without damage.

Circle No. 239 on Subscriber Service Card

Low-Noise Amplifier

Keithley Instruments Model 103 is an a-c preamplifier intended to give the best possible signal-to-noise ratios to oscilloscopes and recorders. It has a noise level of less than 0.8 microvolt rms between 10 cps and 10 kc. The unit lowers the microvolt measurement threshold over a bandwidth of 0.1 cps to 100 kilocycles. Bandwidth can be selected by using 11 high- and low-frequency cutoffs between 0.1 cps and 100 kc. Noise level can be altered by means of a "normal" (input impedence 10 megohms) switch and a "low noise" (input impedance at least 100 K ohms) switch. Amplifier gain may be set at either 100 or 1000 and adjusted to precise values.

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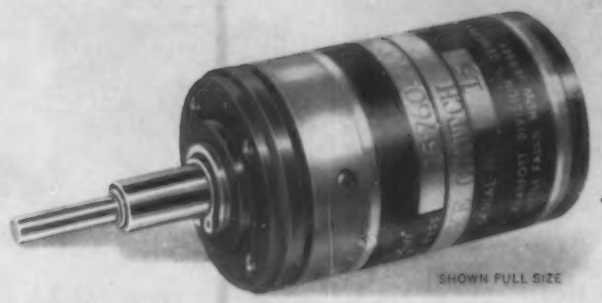

MINIATURE, HIGH PERFORMANCE MAGNETIC BRAKES AND CLUTCHES

Typical applications involving these Size 11 magnetic clutches, brake clutches, and brakes include service as output controls in mechanical differential computers, as motor brakes, and as speed changers and uncouplers. Kearfott can also provide magnetic clutches, brake clutches and brakes in various other sizes to suit desired applications. Components also available in sizes 8 and 6 diameters.

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	Magnetic Clutches		Magnetic Brake Clutch	Magnetic Brake
Unit No.	**R5750-001**	**R5750-002**	**R5760-001**	**R5770-001**
Size	11	11	11	11
Power input (Watts)	3	3	3	3
Clutch Torque (In. Oz.)	6 (energized)		4 (energized)	–
Brake Torque (In. Oz.)	–	–	6 (de-energized)	16 (energized)
Inertia (gm cm²)	.82 (energized) .56 (de-energized)		.82 (energized) .56 (de-energized)	.34
Engaging Surfaces	Steel	Brake Material	Steel and Brake Material	Steel
Environmental Performance	Per MIL-E-5272A			
Life (Cycles)*	3,000,000			

*1 Cycle=1 revolution of shaft engaged and 1 revolution of shaft disengaged, at 500 RPM.

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BOEING

names in the news

TOIVONEN

VAUGHAN

BECK

Dr. Leo S. Packer: Former chief engineer, appointed manager, Military Products Div., Bausch & Lomb Incorporated, Rochester, N.Y.

H. E. Jones: Executive vice president, Electralab Printed Electronics Corp., and a vice president of the parent Farrington Mfg. Co., Needham Heights, Mass., appointed senior vice president in charge of Electralab and three other subsidiaries.

Arthur J. Raymo: Formerly with Baldwin-Lima-Hamilton Corp., joins Kansas City division of The Bendix Corp. as director of manufacturing. The division is operated by Bendix for the Atomic Energy Commission.

Al Lujack: Washington, D.C., insurance executive and manufacturer's representative for over 20 years, appointed government representative for MPI Glass Fibers, Inc.

Philip S. Hessinger: Manager, Research & Development Div., and **Adolf J. Strott,** manager, Manufacturing Div., named vice presidents, National Beryllia Corp., Haskell, N.J.

J. J. O'Brien: Manager of The Garrett Corp.'s AiResearch Mfg. Div. of Arizona, and a member of the Garrett board of directors, named a vice president of the corporation. **Jack Lewis,** formerly director of manufacturing for Garrett, named vice president in charge of manufacturing.

Arnold A. Toivonen: Former assistant manager of Rocket Mfg. Div., appointed manager, Technical Services Div., Aerojet-General Corp.'s Solid Rocket Plant, Sacramento, Calif. Toivonen replaces **W. J. Hix,** named assistant manager of operations at Aerojet's Azusa, Calif., plant.

John A. Vaughan: Appointed manager, DuMont Military Electronics Dept., Fairchild Camera and Instrument Corp.'s Defense Products Div., Syosset, N.Y. Prior to joining Fairchild, Vaughan was manager of projects support, RCA's Missile and Surface Radar Dept.

W. C. Loeman: President, Parker Aircraft Co. Div., and **S. A. Rogers, Jr.,** president, Parker Seal Co. Div., elected vice presidents of the parent company, Parker-Hannifin Corp.

Bernard M. Wilner: Joins Electro-Optical Systems, Inc., Pasadena, Calif., as principal scientist, Fluid Physics Div. Formerly Wilner was project manager for the SNAP-8 power conversion system. Aerojet-General Corp.

John R. O'Brien: Appointed corporate director of government relations, Hoffman Electronics Corp., and will continue as manager of the Washington, D.C., office, and a vice president of the Military Products Div.

J. D. Schetzer: Appointed associate director, Aerosciences Laboratory; **James R. Dunn,** named senior staff engineer; and **Robert C. Anderson,** associate director, Propulsion Laboratory; Mechanics Div., Space Technology Laboratories, Inc., Los Angeles.

T. H. Beck: Veteran of more than 30 years' experience in aeronautical engineering and former engineering manager-Product Development, named director of engineering, Aerospace Div., Ryan Aeronautical Co., San Diego.

James W. McNabb: Former head of Communications Sciences and Systems Dept., The Bendix Corp., appointed assistant general mnager, Strand Engineering Co., Ann Arbor, Mich. Other appointments are: **Richard Eschelbach,** supervisor of Theoretical Analysis Dept.; **Leonard E. Newland,** responsible for planning and marketing activities; and **Robert H. Johnson,** responsible for development of data processing and display systems. Strand Engineering is a division of Datronics Engineers, Inc., Bethesda, Md.

William A. Ogletree: Appointed general manager, Sarasota Products Div., Electro-Mechanical Research, Inc. Before joining EMR, Ogletree was vice president and general manager, Computer Systems, Inc. **James R. White** named manager of the Satellite Integration Facility recently established by EMR in College Park, Md. Previously White was a senior aeronautical scientist at NACA, Langley Field, Va.

contracts

NASA

$146,650—**J. W. Fecker Div., American Optical Co.**, Pittsburgh, Pa., for development of a sidereal test stand for testing gyroscopes and other inertial guidance components.

MISCELLANEOUS

$2,245,997—**B. F. Goodrich Aerospace and Defense Products Div.**, from **Navy** and Air Force, for *Sidewinder* rocket motors, aircraft tires, de-icers and glare shields for fighter aircraft.

$2,000,000—**General Dynamics Corp., Electric Boat Div.**, Groton, Conn., from **Reynolds International, Inc.**, for design and construction of aluminum research submarine.

$600,000—**Adler Electronics, Inc.**, from **RCA**, for production of high-frequency, single-sideband, dual-diversity receivers.

$300,000—**Microwave Associates, Inc.**, from **Western Union Telegraph Co.**, for microwave tubes for use in transcontinental microwave beam system.

NAVY

$25,000,000—**General Dynamics Corp.**, Pomona, Calif., for additional production of advanced *Terrier* and *Tartar* guided missiles.

$10,937,758—**Bendix Radio Div., Bendix Corp.**, Towson, Md., for operation and maintenance of downrange instrumentation facilities along Pacific Missile Range.

$10,845,000—**Bendix Corp.**, Mishawaka, Ind., for development of first phase of long-range *Typhoon* missile.

$9,091,327—**Northern Ordnance, Inc.**, Minneapolis, for additional production of *Tartar* guided missile launching systems.

$7,000,000—**Massachusetts Institute of Technology**, Cambridge, for research and development of *Polaris* missile guidance.

$2,028,950—**International Telephone & Telegraph Corp.**, Fort Wayne, Ind., for target detecting devices for *Terrier* missiles.

$989,118—**Maxson Electronics Corp.**, from BuWeps, for production of anti-submarine detection devices (two contracts).

$574,650—**Scope, Inc.**, Falls Church, Va., for engineering and production of countermeasures set AN/TLQ-14.

ARMY

$171,821,000—**Western Electric Co.**, North Carolina, for development and testing of *Nike-Zeus* system for an additional 12 months.

$13,000,000—**General Dynamics Corp.**, Pomona, Calif., for continued development of the *Mauler* missile system.

$9,394,552—**Raytheon Co.**, Waltham, Mass., for engineering services and documentation on *Hawk* missile system.

$3,000,000—**Continental Electronics Mfg. Co., subsidiary of Ling-Temco-Vought, Inc.**, for design of a multimegawatt radar transmitter for *Nike-Zeus*.

$1,565,000—**Western Electric Co.**, Winston-Salem, N.C., for production of components for *Nike-Hercules* missile system; $1,500,000 for engineering documentation on *Nike-Ajax* and *Nike-Hercules* systems.

$285,000—**Electronic Associates, Inc.**, Long Branch, N.J., for a large transistorized analog computer.

AIR FORCE

$9,000,000—**Kollsman Instrument Corp., subsidiary of Standard Kollsman Industries**, New York City, from **North American Aviation**, for astro tracker systems and spares for *Hound Dog* missiles.

$7,000,000—**General Telephone and Electronics Corp., Sylvania Electric Products, Inc.**, Mountain View, Calif., for engineering and production of receiving equipment.

$2,000,000—**General Electric Co., Defense Systems Dept.**, Syracuse, N.Y., for precision trajectory measurement systems for tracking ballistic missiles.

$2,000,000—**AC Spark Plug Div., General Motors Corp.**, Flint, Mich., for special training of Air Force personnel in depot-level maintenance on *Titan* ICBM inertial guidance system.

$1,700,000—**Republic Electronics**, Farmingdale, N.Y., for production of single-sideband radio systems.

$1,430,500—**Hughes Aircraft Co.**, Culver City, Calif., for production of components, spare parts and data for radar sets.

$600,000—**Pacific Semiconductors, Inc.**, Hawthorne, Calif., from **The Boeing Co.**, for electronic parts for *Minuteman* ICBM program.

$58,000—**Avien, Inc.**, Woodside, N.Y., for study to determine feasibility of array-type antennas for use in missile tracking and telemetry systems in super-high-frequency band.

$50,000—**General Electric's Specialty Control Dept.**, Schenectady, N.Y., from **Lockheed Aircraft Corp.**, for high-reliability sealed relays for use in space vehicles.

OPPORTUNITIES

Anti-missile Missile Systems Div., Industrial Operations, Army Rocket and Guided Missile Agency, U.S. Army Ordnance Missile Command, Redstone Arsenal, Ala.

The Army Rocket and Guided Missile Agency, through the New York Ordnance District, proposes to award a supplement to the *Nike-Zeus* research and development contract with Western Electric Co., Inc.

The proposed supplement will provide for continued system development from 1 Oct. 61 through 31 Sept. 62.

Competitive solicitation is precluded because of the continuing nature of the effort and initial development.

This synopsis is to publicize possible subcontract opportunities and all inquiries relative to subcontracting must be referred to the selected prime contractor—Western Electric Co., Inc., 222 Broadway, New York 38, N.Y.

Directorate of Procurement/FTKRS, Headquarters, Air Force Flight Test Center, Edwards Air Force Base, Calif.

Research and Development sources sought—Program Area 750G.

Firms having research and development capabilities in the field of liquid rocket engines and whose facilities and personnel are qualified to undertake practical studies, hardware design, and testing associated with energy propellants are invited to submit complete information to the purchasing office listed above.

The contemplated effort will be to investigate the technical problem areas associated with the utilization of high-energy propellants in rocket engines. The engine is to utilize advance design concepts in hardware design. Performance demonstrations will be made at the 25,000 to 50,000-lb. thrust level.

A contract of nine months duration is contemplated.

It is important that the company selected to perform these services must have a demonstrated experience in high-performance liquid rocket engines. Respondents should have technical personnel with experience in design, development, fabricating and testing of liquid rocket engines. Among the personnel required will be designers, test engineers, metallurgists and chemists.

Information provided should include the total number of employees and professional qualifications of scientists, engineers and technical personnel, a description of general and special facilities, and outline of previous projects, other available descriptive literature, and a statement regarding industrial security clearance, if previously granted.

For further details, contact G. L. Rucker Wells.

senior engineer / scientist

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National Aeronautic and Space Engineering and Manufacturing Meeting, sponsored by Society of Automotive Engineers, Hotel Ambassador, Los Angeles, Oct. 9-13.

Space Flight Report to the Nation, American Rocket Society, New York Coliseum, New York City, Oct. 9-15.

American Standards Association National Conference, Rice Hotel, Houston, Oct. 10-12.

Symposium on Shock, Vibration and Associated Environments, sponsored by DOD, Office of Director of R&E, Detroit, Oct. 10-12.

Optical Society of America Meeting, Somerset Hotel, Boston, Oct. 12-14.

17th Annual ISA Instrument-Automation Conference and Exhibit, New York Coliseum, New York City, Oct. 15-19.

American Society of Tool Engineers Semi-Annual Convention, Royal York Hotel, Toronto, Oct. 16-18.

Second International Congress, International Organization for Vacuum Science and Technology, Eighth Annual Symposium of the American Vacuum Society, Washington, D.C., Oct. 16-19.

National Conference on Industrial Hydraulics, Versatility and Reliability of Fluid Power, Sherman Hotel, Chicago, Oct. 19-20.

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Russian Boosters

(Continued from Page 41)

Besides the Russian practice of making each new rocket design a major step forward rather than a minor modification, the estimate of 3 million lbs. or more for the thrust of the new rocket, is supported by Khrushchev's recent statement that they now knew how to land a man on the moon but were not yet prepared to bring him back. A 3-million-lb.-thrust booster (*Saturn C-3* thrust) should be adequate for "mooning" a man (as Khrushchev says), but only marginal for "demooning" him.

The space payload growth curve (Figure 2) which is an indication of maximum capability during a given time period, indicates a Russian capability for 25,000 to 30,000-lb. payloads in orbit in the first half of 1962, if they chose to use this period to make a major advance in capability. Successful orbiting of such payloads would be a strong indication that they had in fact doubled their booster thrust as estimated. Use of hydrogen-oxygen propulsion for upper stages could increase this payload capability by another factor of two.

If these booster and payload advances develop as indicated on Figures 1 and 2, then we can expect Russian attempts at manned cislunar and circulmunar flights in the next two years.

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A Lesson From the Past

WE USUALLY DO NOT concern ourselves on this page with book reviews. They appear elsewhere in the magazine. But there is a book just out which we feel everyone connected with the missile/space industry should read. Indeed, the nation would benefit if every American could read it, including the President.

The book is "Combat Missileman." Its authors are Bill Howard, our managing editor, and Jim Baar, our senior editor for military affairs.

Do not let the perhaps unfortunate title deceive you. "Combat Missileman" effectively covers a much more sweeping area than its name implies. Its punch lies in its blunt analysis of the politics and military strategy which underlie our missile and space programs.

It paints in the clearest way the danger facing this nation today as a result of the indecisiveness which afflicted the start of our missile and space programs.

Through careful research and good reporting, the authors lead you back to the sticky summer of 1953 when Trevor Gardner, then Air Force special assistant for research and development, together with Convair's Charlie Bossart and William Patterson, was fighting for an all-out ICBM effort. It is very pertinent to be reminded of that situation eight years ago:

"Many officials in the Administration and the Air Force remained opposed to beginning a top-priority program to develop an ICBM. The Administration did not want to spend the billions of dollars that would be needed."

This, at a time when the Soviet Union already was far along with its own ICBM program.

We are calling your attention to this book on this page today because the nation once again stands at a decisive crossroads for an important military program. We are talking about the *Nike-Zeus* antimissile missile.

If there is a single clear lesson to be learned from the mistakes of the past, it is that we should not underestimate Soviet capabilities. When the U.S. began its development of the *Atlas* ICBM, there still were many who said that such a missile was an impossibility, that it could not by any stretch of the imagination perform its task of hurling a nuclear warhead onto a target 5000 miles away.

The decision to push ICBM development in the face of those doubts was a carefully calculated risk, a decision that the nation could not afford NOT to spend the money. "Concurrency" became the catchword.

The *Nike-Zeus* stands today in the same position.

There are many who will tell you that the *Nike-Zeus* cannot handle its mission of knocking down incoming ICBM's. There are others who will argue that enemy ICBM's can be attacked more effectively during launch than during the terminal phase of their awful journey. Project *Defender* seeks better ways of tackling the same problem. The Air Force is hopeful that the *Saint* program will provide a satellite force to knock down ICBM's well before the re-entry stage.

Be that as it may—and we wish all other efforts well—*Nike-Zeus* is the only program which offers a possibility of an "early" ICBM defense.

Word in Washington this week is that the latest review of U.S. military programs by President Kennedy and Defense Secretary McNamara has reaffirmed the decision to withhold production funds from *Nike-Zeus* until at least next year.

If production is ordered after the Pacific tests, emplacement of the antimissile missile around U.S. cities cannot begin for another four years—in 1966.

A go-ahead now for long-lead time production items would shave valuable time off that schedule.

Balance the doubts about *Nike-Zeus* against the optimism of the industry and military team which has been working on the program since its inception. Then concede there still is a possibility it might not work effectively.

EVEN WITH THIS concession, can we afford to lose the time-saving offered by an immediate production go-ahead? We never will be convinced that a country rich enough to afford our present standard of living cannot afford the amount of money involved in risking a production start for *Zeus*.

The ugly fallout from Soviet nuclear testing in the Arctic has been followed by reports that the Russians are testing warheads for an antimissile missile.

If anyone has any doubts about the need for deployment of *Nike-Zeus* at the earliest possible date, let him ask himself this question: What happens to the U.S. military posture if the Soviet Union equips itself with an effective antimissile system before this country does?

The answer is that minimum deterrent and counterforce then become theoretical arguments. The first nation to develop such an antimissile system gains an overwhelming military advantage.

Let us remember the summer of 1953:

"Many officials in the Administration and the Air Force remained opposed to beginning a top-priority program to develop an ICBM. The Administration did not want to spend the billions of dollars that would be needed."

Then let us ask what our military and political relationship with the Russians would be today if the decision had gone against the U.S. ICBM program. That is argument enough for a production go-ahead on *Nike-Zeus*.

William J. Coughlin

▸▸ Some day — not far away in time — earthbound intelligence will set up base on the moon.

▸▸ First, perhaps, the robot explorer, such as the "Moonmobile," designed and developed by Space General Corporation, answering many of man's questions about his celestial neighbor. Ultimately — groundbreaking — and the return to earth of the first substance from a foreign planet.

▸▸ Soft lunar landings have been studied in depth by Space General Corporation, America's uniquely capable source for space systems. Space General's management and staff have been part of this nation's ICBM, IRBM and space programs since the earliest days. Familiar accomplishments include the reliable Ablestar space engine. Others are in the making — advanced launching vehicles, commercial and navigational satellites, space based weapon systems and nuclear powered space vehicles.

▸▸ These programs now create opportunities for scientists and engineers of those capable of bringing high levels of skill and energy will be considered without regard to race, creed or national origin. Contact Pierre Blowin, 777 Flower St., Glendale, Calif.

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